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The New Piers for Transatlantic Steamships, Chelsea Improvement, New York City.

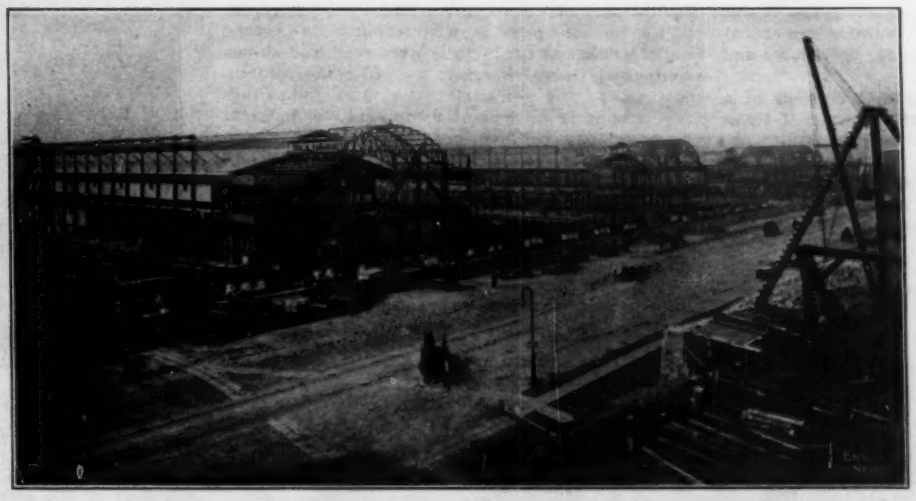
(With two-page plate.)

A group of nine pier-sheds now being constructed in the Chelsea section of New York City, on the Hudson River waterfront, will complete the largest piece of wharfage construction ever undertaken in the port of New York. The piers are unusually large, being planned to give accommodation to the largest steamships of the transatlantic passenger lines. The piers or substructures do not depart widely in their construction from the type heretofore used by the city's Department of Docks and Ferries, a pile pier with creosoted plank decking, the principal novelty being a concrete covering over the planking, surfaced with asphalt pavement, and extra heavy transverse bracing to resist lateral impact. The double-deck steel sheds erected on these piers, however, represent advanced design in several features. The following brief description of the sheds has been prepared from data furnished by Mr. Chas. W. Staniford, Chief Engineer of the department. For the types of construction used in the piers and in the bulkhead or sea-wall, reference may be made to an extended article by Mr. S. W. Hoag, Jr., abstracted in Engineering News of May 18, 1905, pp. 503-511.

In the article just quoted will be found a map (p. 505) which exhibits the relative location of the new Chelsea piers and the piers of the Gansevoort Section, the last previous pier development for transatlantic lines in New York City. A fuller map of the Chelsea piers is given on the inset sheet of the present issue. This latter map, containing the outline of the shore before the improvement, gives a suggestion of the extensive changes which the new work made in this part of the river frontage.

About ten years ago the Department of Docks and Ferries was confronted with the serious condition of having no room for the further extension of the docking facilities along the west front of Manhattan, although such extension was badly needed. The Chelsea Improvement was projected to meet this situation. Small piers of relatively low commercial value occupied the site. To construct piers of length suitable for large vessels, however, required the shore line to be moved inshore several hundred feet, which meant the removal of a ferry terminal (at 14th St.), a large number of factories, dwellings, and part of a gas works, whereby the real estate expenses became very heavy. The improvement comprised dredging the entire land and water area to a depth of 40 ft. at low water, constructing 3,400 lin. ft. of bulkhead wall, building nine pile piers, of which six are 125 ft. wide by 800 to 825 ft. long, clearing, filling and paving with granite the space behind the bulkhead wall to form a marginal street 250 ft. wide, and erecting double-deck sheds on all the piers and along the full length of the bulkhead wall. The completion of the pier-sheds, now in progress, is the last part of the entire work. In the meantime the piers have already been in use to some extent for over a year, the "Lusitania" and "Mauretania" being docked here regularly since entering into commission.

The general arrangement, dimensions and structural elements of the Chelsea pier-sheds are exhibited by the drawings on our inset sheet. The structures may be divided into the pier-sheds proper, and the bulkhead sheds, the latter being the portions lying along the heads of the slips. The distinction between the two is emphasized in the façade, the front wall of each pier-shed being carried up to form a peaked pediment crowned with ornamental figures at the ridge and over the pilasters. Of the several bulkhead sheds, some are entirely inshore of the line of the bulkhead wall, resting on the solid fill, while some are outside of the bulkhead wall on a pile substructure. The latter arrangement occurs in the southerly half of the group, where the bulkhead wall is offset 75 ft. inshore to provide slips large enough for the very longest ships; the arrangement permits the full net length of the slipway (825 ft.) to be dredged to maximum depth without encroaching on the riprapped slope along the river face of the bulkhead wall.



PIER-SHEDS OF THE CHELSEA IMPROVEMENT DURING ERECTION.

THE PIERS.—The construction of the piers, which form the substructure for the sheds, may be recapitulated briefly as follows: The piles are in transverse rows 10 ft. c. to c. lengthwise of the pier, 6 ft. apart in the rows except under columns, etc. The piles of each row are clamped together at the top by pairs of timbers and braced by diagonals. The clamping timbers carry a ranger system of 6 × 12-in. yellow pine timbers in pairs, the pairs being spaced about 3 ft. apart and running the full length of the pier. On these rangers is laid a deck of 4-in. yellow pine planking carrying a layer of concrete reinforced with expanded metal against slight disturbances due to settlement or jarring. The concrete is 4½ to 6 ins. thick, its surface being formed to a crown, and on it is laid a 2¼-in. asphalt pavement. The ranger timbers and the deck-planking are creosoted. The deck thus constructed forms the first floor of the pier-sheds.

SHED FRAMING.—The framework of the pier-sheds consists of transverse bents of columns, roof-truss and floor girders, spaced 20 ft. on centers lengthwise of the pier, arranged as shown in the cross-section on the inset sheet and more fully in Fig. 1. The second story is clear, having no intermediate columns, but the first story contains a central line of columns under the floor girders.

The roof-trusses, carrying a wide central monitor with swing-sash in its vertical sides, are of a form typical for moderate roof slope. Their span is 94 to 118 ft. c. to c. of columns, except in the case of the narrow half-piers 53 and 62. The trusses are of special design only in being proportioned to resist the pull on the backstays of the cargo-hoist system, as noted in Fig. 1. The roof planking is carried on 10-in. channel purlins of 20-ft. span. The monitor frames, 6 ft. 8 ins. on centers, rest on longitudinal lattice-girders riveted to the vertical members of the trusses one panel each side of the middle. The monitor trusses are braced together by 3 × 2½ × 5-16-in. angles in their bottom-chord plane. The main roof trusses have crossed diagonals of ⅞-in. round rods in the inclined top chord, and ¾-in. round rods in the horizontal top chord, in every other bay. The roof system is designed for the following loads: on monitor truss and longitudinal girders, 65 lbs. per sq. ft.; on purlins, 63 lbs. per sq. ft.; on roof trusses, 70 lbs. per sq. ft., in addition to the cargo-hoist pull; these values being considered to include wind effect on the trusses.

The roof system as described extends only over that part of the pier-shed lying outshore of the bulkhead sheds. The part which extends between the bulkhead sheds forward to the street line has arch-shaped roof-trusses as shown in Fig. 10, without monitor. This part of the roof is at a higher elevation than the main pier-shed roof; the short wall section connecting the two has windows for lighting the second story space,

There is also a variation at the outer ends of the sheds. The river ends of the pier-sheds have an ornamental structural steel skeleton with an arched transom effect in the second story, filled with pivoted and swing sash of hammered and plate glass. The second story terminates 40 ft. from the end of the lower story of the pier, and the projecting shelf thus formed is utilized as a promenade for the accommodation of friends of departing or arriving passengers. The lower story, under this promenade, contains a mezzanine for gear room and quarters for stevedores and third-class passengers.

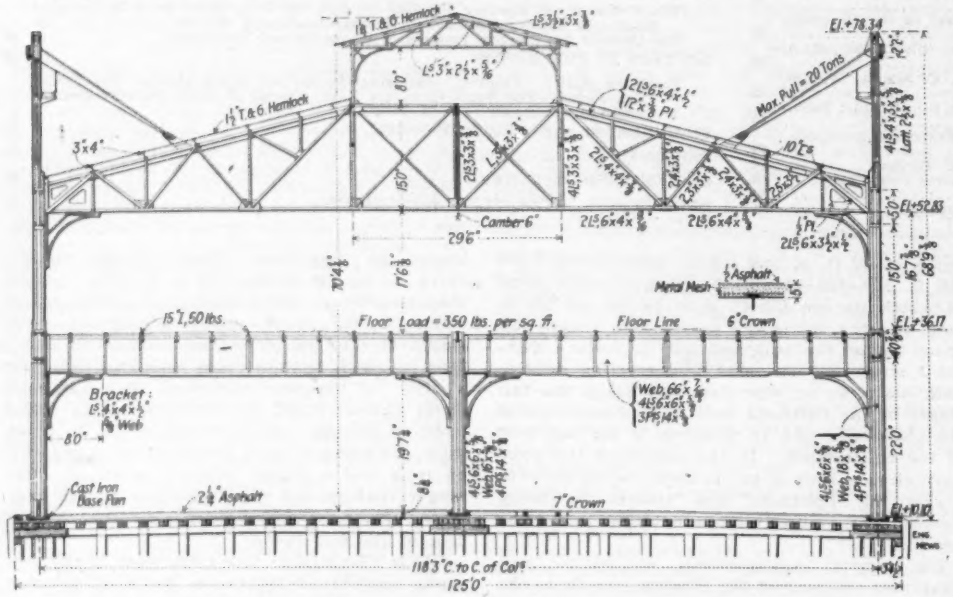


FIG. 1. CROSS-SECTION OF PIER-SHED ON 125-FT. PIER.

The second floor of the pier-shed consists of a 5-in. reinforced-concrete slab between I-beam joists spaced about 5 ft. apart, framed into transverse plate-girders connected to the side columns of the bent and resting on the middle columns. In each alternate bay of the floor is a horizontal bracing system of 4 × 3 × ⅜-in. angles. All parts of the floor are designed for a total load of 350 lbs. per sq. ft. The floor slab extends 1 in. below the top flange of the floorbeams, and is reinforced with mesh reinforcement. It was made of 1:2:4 concrete, the stone being ¼ to ⅝-in., and was laid in strips 10 ft. wide, to distribute the shrinkage and expansion. A ½-in. layer of asphalt forms the wearing surface.

The side columns are of built I-section, 18 ins. wide up to the trusses, with web-plate, and extended upward as a latticed I-section 12 ins. wide to form masts for the cargo hoists. They rest in cast-iron base pans, made to fit the transverse slope of the decking and furnish a level surface for the foot of the column. These pans were set at the time the piers were built, but before erecting the columns their levels were read and shims were used where necessary to bring the column foot up to the same elevation. As indicating the amount of settlement to be expected in such work, it may be mentioned that the levels on Pier 60 just before beginning steel erection showed a maximum settlement of 0.16 ft., and levels taken at the same point since the erection of the shed showed a further settlement of 0.17 ft. The shims used were steel plates of the required thickness and of the full size of the column base-plate. A maximum thickness of shimming of 2 ins. was allowed. After completion of erection, the pans will be filled with concrete and finished off with asphalt to correspond with the rest of the deck.

The column extensions above the roof carry longitudinal girders to which are to be attached blocks and falls for handling cargo. These girders are designed for two loads of 10 tons 8 ft. apart. At six points on each side of the pier, fittings for coaling derrick booms are provided. The top of each column is tied back to the roof truss by angles, and an intermediate point of each girder is tied to the same point of the truss by 1¼-in. round rods. In the longitudinal plane there is bracing of crossed ¾-in. round diagonals between the masts, in the height between roof and cargo girder. The columns are designed for a load of 310 lbs. per sq. ft. floor area, in addition to wind pressure and cargo hoist loads. To facilitate the handling of the blocks and falls, a walkway bracketed to the columns and provided with a pipe railing extends from end to end of the pier-shed on each side.

The bulkhead sheds have a generally similar framing. The bents here are transverse to the line of the shed, i. e., parallel to the pier-sheds, so that the trusses have 75-ft. span in the sheds of the northerly half and 50-ft. span in the southerly sheds. The roof of the bulkhead sheds is pitched from the street side downward toward the river, and has no monitor. The floor and column construction is similar to that of the pier-sheds. However, a somewhat lighter floor load was used for the second floor, namely, 210 lbs. per sq. ft., instead of the 350 lbs. used for the second floor of the pier-sheds. The same arrangement of floor and roof bracing was used.

Fig. 3. Pier 56; Framework of Front Before Concreting Wall.

Mezzanine floors occur at a few places in both sheds, and these were proportioned for the same loads as the second floor of the bulkhead sheds.

The sheds are braced transversely to withstand a wind pressure of 30 lbs. per square foot of side. Each bent of the pier-sheds is braced by means of four curved kneebraces, as shown in Fig. 1, connecting the columns with roof-truss and floor girders respectively. Longitudinal resistance is furnished by two longitudinal girders along each side of the pier-shed forming a portal system, one of which is at the eave and the other at the level of the second floor. They are box-girders with plate webs on three faces (inner face open), and besides acting as bracing they serve as door heads, for attaching the tracks or pivot shafts of the doors. Similar longitudinal girders are provided in the front and rear faces of the bulkhead sheds, and these sheds also have kneebraces in each bent except at the front wall.

No provision has been made in the steel frame for taking up settlements (except at the front wall, as will be described farther on), since the settlement of the pile work is expected to be practically uniform. Temperature movements are provided for in the case of the pier-sheds by expansion joints (slotted connections) near their inshore ends, where they join the bulkhead sheds,

FIG. 2. VIEW ALONG SIDE OF FINISHED PIER-SHED, CHELSEA IMPROVEMENT.
Sectional lift doors in lower story, horizontally sliding doors in upper story. Masts for cargo hoists at all columns.

and in the case of the bulkhead sheds (whose framing is structurally continuous with that of the intervening sections of the pier-sheds) by expansion joints 1,125 ft. apart.

ROOF AND SIDES, ETC.—The roof of both pier and bulkhead sheds consists of five-ply felt with tar-and-slag covering, laid on 1½-in. matched spruce sheathing. Gutters are formed at the eaves according to the detail Fig. 12, drained to 5-in. galvanized wrought-iron pipes carried down along the outside of the columns and through the deck of the pier.

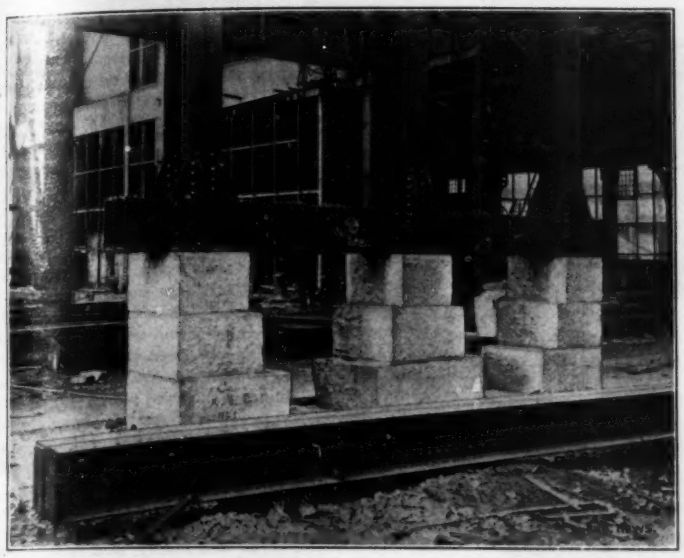


FIG. 4. JACKING GIRDERS AT BASE OF FRONT WALL COLUMNS.

If the weight of the concrete front wall causes settlement of the fill subsoil, the steel work can be raised up to its original level by jacks set under the jacking girders, and permanent blocking then placed between column base and granite footing.

All sides of the sheds (except the street front) are covered, where windows and doors do not occur, with 20-gage galvanized corrugated sheet attached to the usual framework of channels and angles.

Partition walls are constructed of 4-in. terra-cotta block filling in channel and angle framing. Where these walls face waiting-rooms or the like they are finished in three-coat plaster, while elsewhere they are covered with 22-gage galvanized sheet; where they form outside walls, as at the river end of the lower story of the pier-sheds, a layer of rosin-sized paper is placed between the terra-cotta and the galvanized iron.

Waiting-rooms, offices, etc., in the pier-sheds have a ceiling of stamped sheet-steel. Similar rooms in the bulkhead sheds are ceiled with plaster on metal lath and furring.

CONCRETE FRONT.—Architectural considerations made it desirable to build the street front of a more permanent material than sheet-metal as has been used for all previous pier-sheds. The first intention was to use brick, with terra-cotta or concrete trimmings, but later concrete was fixed upon for the purpose.

The question of color and finish was dealt with by experimenting, which led to the decision to use a 1:2:4 mixture made with beach gravel, and to tool the surfaces after the concrete is well hardened. Special ornaments, headpieces, keystones, etc., are to be cast in place in finished molds, with no subsequent tooling.

To guard against cracking, the concrete is reinforced throughout with expanded metal wired to vertical ½-in. round rod stays. There are two other important supplementary provisions, however, namely, (1) vertical joints in the wall at intervals of 100 to 350 ft., and (2) radial surface grooves in imitation of joints in the concrete over the large arched opening at the entrance to each pier-shed and a similar distribution of imitation joints in the front wall of the bulkhead sheds, in which grooves any tendency to cracking is expected to localize.

Where the front wall rests on filled ground (the northerly section) considerable differential settlement may occur between the piled work and the front wall; similarly in the southerly section, where the front wall rests on the bulkhead wall, the settlement of the latter may be expected to differ from the settlement of the piled portions of the shed outshore of the wall. These effects are especially important in the Chelsea piers because of the added weight of the front wall, which would tend to exaggerate the differential settlement. Such settlement would cause differences of level in the floors and distortions in the framework; it was considered necessary therefore to provide means for jacking up the frame to take up the differences. In the front wall of the bulkhead sheds it was possible to keep the concrete independent of the steel frame, so that the latter could be jacked up without affecting the wall. In the front wall of the pier-sheds, however, this was not possible, as the concrete is not designed to sustain itself across the large central arch, but rests on the steel frame of the opening, which in turn is connected to the floor and roof framing. When jacking is necessary in this portion, therefore, the wall must be raised together with the steelwork. Obviously this condition required a separation between the concrete of the pier-shed front and of the bulkhead shed front respectively. A vertical joint as detailed in Section D—D, Fig. 10, was used for the purpose. The offset in the outer face at the joint, which the drawing shows, is a feature of the architectural development, ingeniously utilized to accommodate the joint. The clear distance between rabbets inside the joint is sufficient to allow for a certain amount of canting which may result from settlement.

The arrangement for allowing the front-wall columns to be jacked up is shown by the photograph Fig. 4. A horizontal girder is built integral with the column base, long enough to project laterally beyond the granite foundation so as to furnish abutments for lifting jacks. These girders consist of two channels and an I-beam. The anchor-bolts extending up from the foundation are extra long, and the nuts are screwed down over 12-in. sleeves to allow for jacking up the steel without lifting it off the anchor-bolts.

The base of the wall extends down in front of the footing masonry, while at the rear a lath-and-plaster partition or screen is built in the lower story of the shed, thus enclosing each group of column bases in a closed space readily accessible for inspection or for jacking operations. As the columns and jacking girders are entirely clear of the wall the work becomes relatively simple.

In the case of bulkhead shed wall, it is the concrete wall itself which extends down in front of the column footings as described, and this wall, resting on a foundation independent of the column footings, is self-sustaining and is not raised when the steelwork is jacked up. In the main pier-shed fronts, however, the wall concrete extends down to the granite base and behind the base as a backing down to the foundation, with a horizontal joint behind the neck molding of the granite base course. The concrete wall being firmly connected with the steel frame, it is expected that in jacking up this portion of the work the concrete wall will rise with the steelwork under the operation of jacking and separate at the above-described horizontal joint. It should be mentioned that the granite base course is also carried along the entire front of the bulkhead sheds as a facing to the concrete, with reveals at all door openings to the inner line of wall. The material is Stony Creek granite.

The constructional details of the front wall are given by Fig. 10. It may be noted that the concrete wall is 9 ins. thick to a level of 9½ ft. above ground, 6 ins. thick from here to the second floor level, and 4 ins. thick above this, thickened to 6 ins. at the vertical members of the steel frame for better attachment of anchors. At each vertical two ⅛-in. rods are embedded in the concrete, and hook-shaped anchors looped around the pair of rods project from the inner face and engage the vertical member of the frame. These anchors in the bulkhead shed wall are intended to be capable of slipping along the steel member, thus permitting relative vertical displacement of frame and wall in case of jacking, as described.

The wall is carried up above the roof as a parapet wall, turned horizontally and carried down behind the upward projecting guide members of the steel frame as a return wall to the roof level. The pocket thus formed permits the steel to be lifted without fouling the wall. A total of about 12 ins. of vertical movement is provided for. In the pier-shed front the hollow parapet is much wider, and is stiffened by steel frames inside which are riveted at the front to the vertical angles which carry the concrete work. The rear members of the parapet frames rest on the purlin channels of the roof; a 6-in. angle extending transversely down the curve of the roof along the foot of the rear member of the frames forms a seat for the rear wall of the parapet. In all cases the joint between parapet and roof is flashed and counterflashed with 22-gage galvanized iron.

The radial lines drawn on the concrete wall

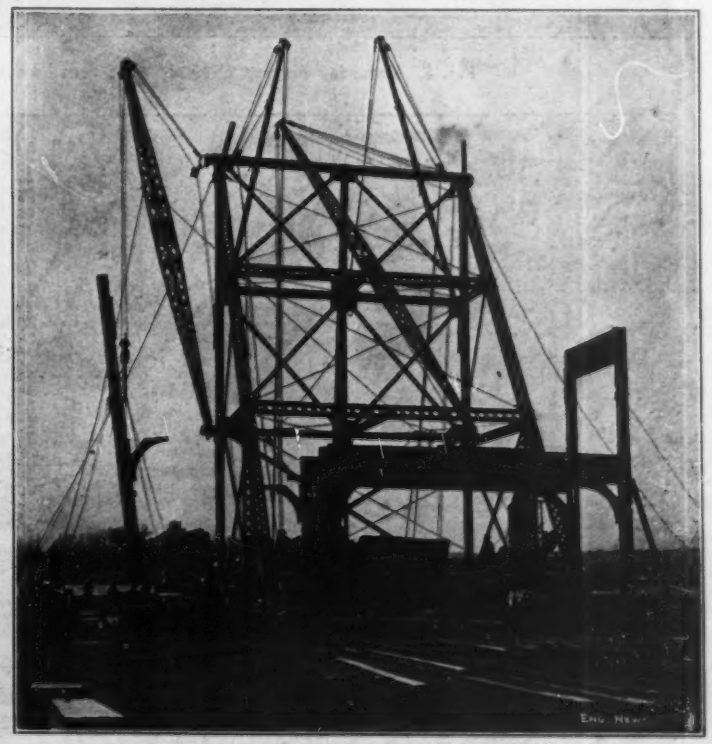


FIG. 5. DERRICK TRAVELER USED IN ERECTING PIER-SHEDS ON PIERS 54, 56, 60, 61 AND 62.

above the arched main entrance, Fig. 10, denote the grooves already referred to, which are intended to concentrate any excessive strains along these lines, producing inconspicuous straight radial cracks in the grooves rather than irregular cracks on the plane face. In placing the concrete, work was continuous except that a day's work might be stopped along the imitation joints, so that there should be no lines weaker than the groove lines.

DOORS.—The requirements of the steamship companies who lease the piers led to designing a new form of door for the openings in the sides of the pier-sheds, a door meeting all needs as to cargo-handling facilities, protection and ventilation, that is, a door that may be opened to full capacity for handling heavy, bulky cargo; a door that may be opened only partially, for handling lighter cargo; and a door that may be opened for light and air and yet form a closed fence against the depredations of river thieves. A drawing of the door is given in Fig. 11, together with sketches showing its various positions.

Fig. 6. Monday July 27, 1908; 97 tons erected.

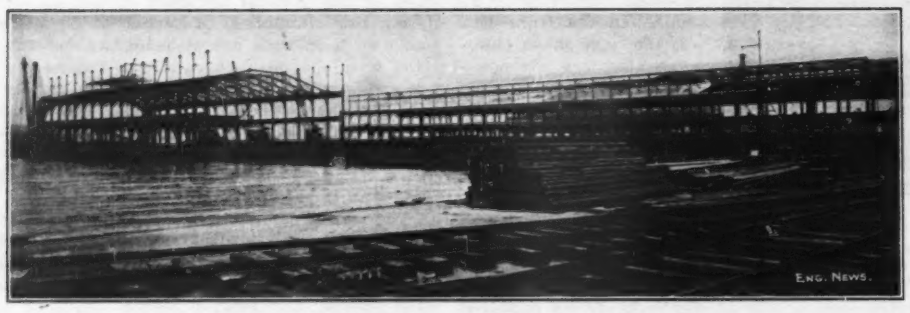


Fig. 7. Wednesday July 29, 1908; 701 tons erected.

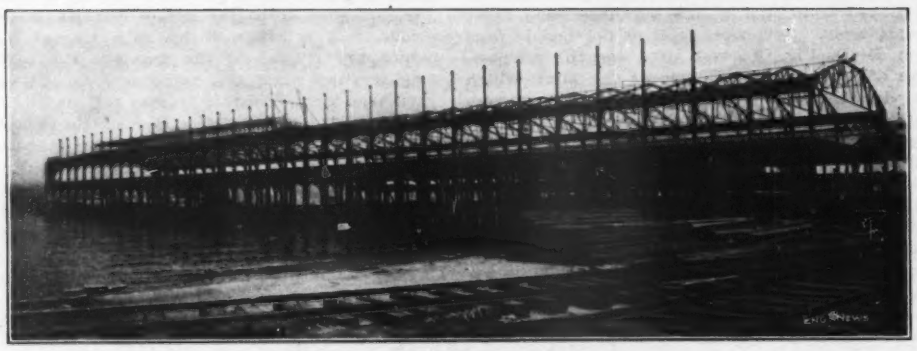


Fig. 8. Saturday August 1, 1908; 2496 tons erected.

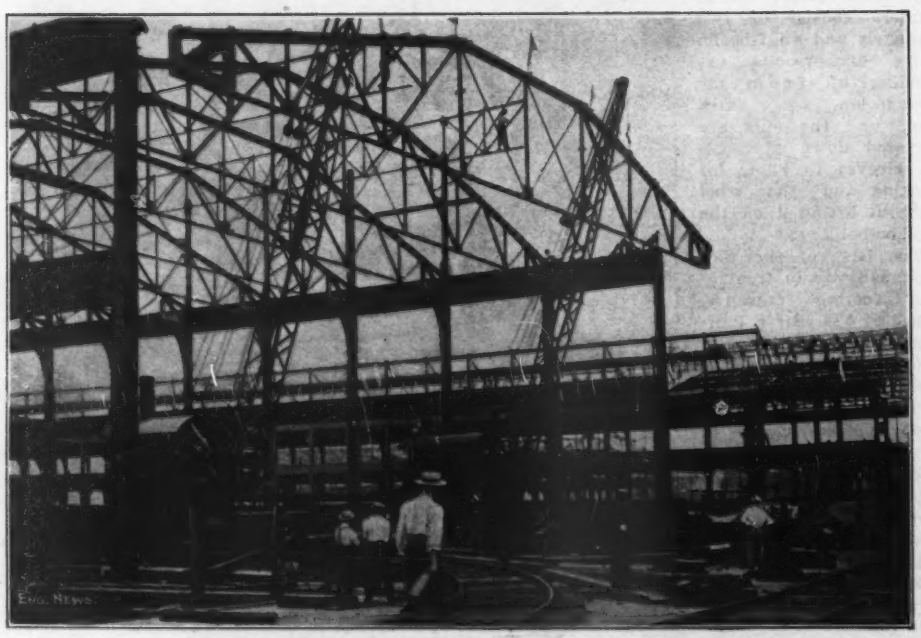


Fig. 9. Derrick Cars Setting Last Truss of Pier Shed 59, Saturday August 1, 1908.

FIGS. 6-9. RAPID ERECTION OF STEEL FRAME OF SHED, PIER 59.

The door consists of an upper and a lower section; the upper section is hinged at the top to swing inward, while the lower section moves vertically in guide grooves along the rear face of the upper section, being hung on lift-chains carrying counterbalance weights. When the lower section is down it is held in stops in the side wall of the shed, and the upper section then may be tricked up for ventilation and light; when the lower section is raised, both sections may be tricked up together, leaving the full door-opening clear. The lower section being on the inside, and necessarily lapping up beyond the bottom edge of the upper section, the latter can not normally swing inward while the lower section is down; however, by turning down a hinged strip which forms the upper edge of the lower section, the upper section can be swung in clear of the lower section. This hinged strip when folded up, as with door closed, is held in position by a set of sliding bolt locks.

As fitted in the first of the Chelsea sheds, these doors are fitted with hand hoist for tricing up. The doors being large and heavy, and there being a very large number in a single pier, hand operation is very time-wasting, however, and plans have therefore been drawn for power hoisting gear. This comprises a motor-driven line-shaft hung to the girders near either side of the shed, and a friction-clutch countershaft for each door, the countershaft carrying a winding drum over which the lifting rope is coiled. Three or four sections of line-shaft, each driven by one motor, would be sufficient for the full length of the pier side.

This type of sectional lift doors has been put in on the lower deck of all the sheds, except at a few door openings where a mezzanine floor in the first story interfered, and where, therefore, rolling doors had to be used. The sectional door has also been installed in the second story of all the pier-sheds except those occupied by the Cunard Steamship Co., which preferred horizontally sliding doors. These latter are mounted in Allith hangers, which have pairs of concave-tread wheels running on a double track of split pipe. The hangers have vertical and horizontal adjustment; four hangers were used per door.

All doors are covered on the outside with galvanized crimped iron and on the inside with tin, put on with locked joints and well nailed. Weather stops of 3 × 8-in. beveled oak plank are provided at the bottom. Windows in the doors are glazed with ¼-in. wire-glass.

OTHER DETAILS.—Windows in the street front of the sheds have copper-covered wood frames. Doors in the front consist of inside and outside ⅞-in. oak sheathing on white pine frame.

The pivoted windows in the sides of the monitors of the pier-sheds are operated by the usual type of gearing, in blocks 100 ft. long (15 windows), the gear being worked from the floor of the second story.

The floors of the main waiting-rooms and of the offices are of maple. Those in the third-class waiting-rooms, the vestibules and the toilet-rooms are of interlocking rubber tile. All other rooms are floored with yellow pine. The mezzanine floors have cement finish on the reinforced-concrete floor slab.

A perforated pipe system for fire protection is installed on all the piers, comprising longitudinal lines of perforated 4-in. pipe, two lines in each 100-ft. pier and three lines in each 125-ft. pier. These pipes are below the floor, about 12 ins. below the clamping timbers of the piles, and their sole purpose is to protect against fire arising or spreading in the timber substructure. Each line of pipe is divided into blocks of about 200 ft., and separate floor-connections for land engines or fireboats are provided in each section.

Of the minor items of detail or finish the following may be mentioned:

All sheet-metal work (galvanized or tin-plate), which covers practically the entire outer wall surface (except the street front) and much of the interior, is given a priming coat of graphite paint and two finish coats of lead and oil on interior work and three on exterior work. All exposed wood work is given four coats of paint. A coat of fire-retardant paint was applied to the under surface of the roof boarding. The structural steel was given one coat of paint in the shop, one coat (graphite paint) after erection, and two finishing coats (lead-and-oil paint).

Imitation of Caen stone, with marble base facing, is used in finishing the walls of the vestibule entrances and the main waiting-rooms. The plaster ceilings in the latter are formed in decorative panels.

CONTRACTORS AND PRICES.—The contracts for constructing these sheds were let to the following firms, being the lowest bidders in each instance:

Pier No.	Contractor.	Estimated Cost.	Contract Price.
53	Not yet let.....	.....	.....
54 & 56	Snare & Triest Co...	$1,160,000	$1,132,580
57, 58 & 59	R. P. & J. H. Staats.	1,950,630	1,829,000
60, 61 & 62	Maryland Steel Co...	1,684,644	1,543,900

These contracts include all building work and finish, but without heating, lighting and power equipment. The piers were turned over to the contractors complete with concrete floor and column base pans in place.

The steel construction, which forms the largest single item of the work, was subcontracted to the following firms: Piers 54 and 56, Hay Foundry & Iron Works, Newark, N. J. (fabrication and erection). Piers 57-59, McClintic-Marshall Construction Co., Pittsburg, Pa. (fabrication and erection). Piers 60-62, Pennsylvania Steel Co., Steelton, Pa. (fabrication), and Snare & Triest Co., New York City (erection).

The reinforced-concrete front wall of the whole group of eight sheds covered by the above three contracts is being built by the Ferro-Concrete Contracting Co., of New York City; the granite for the pedestal or base course was obtained from the Stony Creek, Conn., quarries of the John Pierce Company.

RECORD-BREAKING SPEED IN ERECTION.—Rapid erection work was done in all the steel contracts, but a phenomenal record was made on Pier 59 by the McClintic-Marshall Construction Co., who erected 2,500 tons of steel of one shed in a single week, nearly a third of this amount being erected in one day. The four views Figs. 6 to 9 give a graphical summary of the work, and the following table shows the work done each day. Saturday was only a half day, it should be noted.

	Tons.
Monday, July 27, 1908.....	97
Tuesday, July 28, 1908.....	72
Wednesday, July 29, 1908.....	532
Thursday, July 30, 1908.....	780
Friday, July 31, 1908.....	629
Saturday, Aug. 1, 1908.....	386
	2,496

The entire frame of this shed, erected complete in 17 days, totaled 3,293 tons. For comparison, reference may be had to a similar piece of work on an East River pier-shed where also the erection was remarkably rapid (see Eng. News, Jan. 10, 1907, p. 25); in that case a double-deck shed 56 ft. by 545 ft., totaling 350 tons of steel, was erected in 14 days, of which only 9 were working days.

The erection of the McClintic-Marshall steel contracts was handled by means of two derrick-cars, as may be seen most clearly in the view Fig. 9. The roof-trusses, shipped from the shop in three sections, were riveted up on the ground and could then be hoisted into place and bolted to the columns in short order. The floor girders were also hoisted as one piece, the girders of the two sides being set along the side of the deck in herringbone arrangement just outside the track of the derrick-car, in convenient position for being picked up, slung around to transverse position and set in place on the column bracket and the central column.

A different erecting rig was used on the other contracts. A traveling derrick-frame shown by the view Fig. 5 was designed by the Hay Foundry & Iron Works for the sheds on Piers 54 and 56, and the same traveler was afterwards used by the Snare & Triest Co. in erecting the steel of the three northerly sheds.

The steel frame of the entire group of sheds totals 31,000 tons, and represents probably the largest steel contract ever let in New York City, if the great East River bridges and the Rapid Transit Subway are excepted.

These pier-sheds are built and equipped by the city complete. The entire Chelsea improvement was carried out for the city by its Department of Docks and Ferries, and all designs and plans were worked out by the regular organization of the department, the only outside assistance being in the architectural treatment of the sheds themselves, which is the work of Warren & Wetmore, Architects.

The officials of the department feel special satisfaction, therefore, in the close agreement between their estimates of cost and the actual letting prices, as shown by the table given above.

The design of the sheds was begun under Mr. J. A. Bensel as Commissioner of Docks, and is now being carried out under Mr. A. N. Spooner, the present Commissioner. The work is under the direction of Mr. C. W. Staniford, Chief Engineer, and Mr. S. W. Hoag, Jr., Deputy Chief Engineer, Mr. R. T. Betts, Assistant Engineer, being in charge of the preparation of designs, and Mr. J. J. Pemoff, Assistant Engineer, in charge of erection.

The entire project will be finally completed in the latter part of 1909. The pier-shed of Pier 56, leased by the Cunard Steamship Co., is practically completed and is in service.

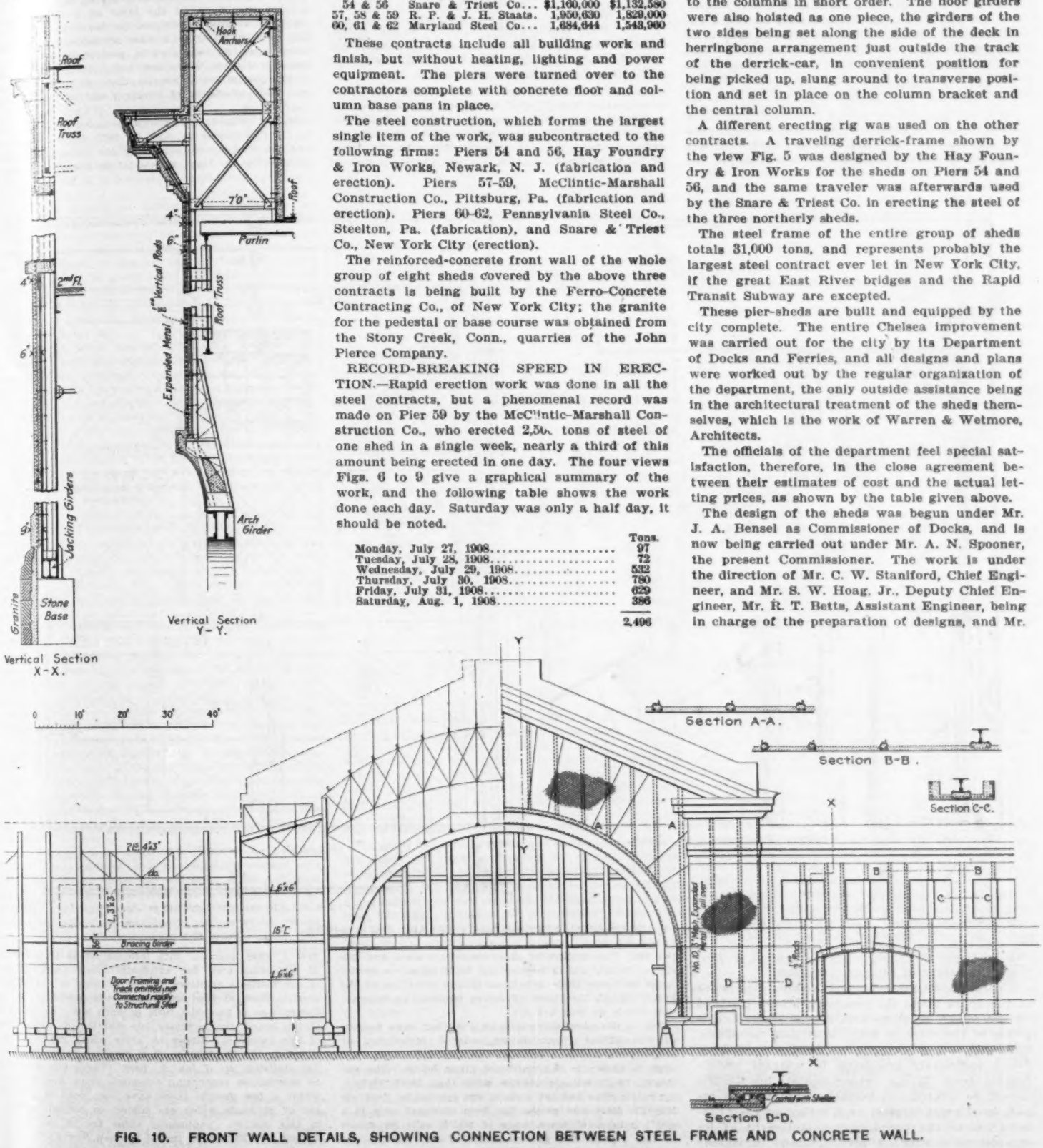


FIG. 10. FRONT WALL DETAILS, SHOWING CONNECTION BETWEEN STEEL FRAME AND CONCRETE WALL.

Block Signal and Control Board: First Annual Report to the Interstate Commerce Commission.

A board to investigate the use of and necessity for block signal systems and automatic control appliances on railways was appointed by the Interstate Commerce Commission in 1907, by direction of a Joint Resolution of Congress approved June 30, 1906. The first annual report of this board has just been issued by the Commission. In March, 1907, Congress appropriated $50,000 for carrying out the objects of its resolution and for making tests of promising signal systems or appliances provided these should be furnished for the purpose free of cost to the Government, and the board was appointed three months later. The work was ordered continued by the Sundry Civil act of May, 1908, and was broadened so as to include the investigation and pulsory adoption of the block system on all passenger lines except those traversed by less than six trains weekly each way. This recommendation has since been indorsed by the board. As block signaling systems are already in extensive use and are highly developed in this country, the board directed its investigations mainly toward the subject of automatic stops and cab signals. However, its report also discusses various block signaling systems to a considerable extent.

The board is composed of Prof. M. E. Cooley (chairman), Mr. Azel Ames, Mr. F. G. Ewald and Mr. B. B. Adams. The following reproduces the body of the report nearly in full:

Up to Nov. 21, 1907, the date of our former [informal] report, about 250 plans of inventions had been received and 55 of these had been examined. Nearly all of these inventions were found to possess little or no merit, the inventors being apparently unfamiliar with the needs of the railroad service as well as ignorant of the state of

Of the 371 files placed under examination, [illegible] have been reported on, and 187 are still in course of [illegible]mination.

Of the 184 files reported on, 168 are signal [illegible] train stopping devices, and 16 are other railway safet[illegible] vices.

Of the 187 files still in course of examinatio[illegible] 60 are signal and train-stopping devices, and 107 [illegible] other safety devices.

Of the 184 files reported on, 12 signal and t[illegible] stopping devices have been considered to possess [illegible]cient merit to warrant the board in saying that if [illegible] proprietors should install the same on a railro[illegible] under practical working conditions the board would [illegible]amine the installations with a view to determining [illegible]ether tests should be conducted at government expe[illegible] Of these 12 devices, 4 are now being installed, 1 [illegible] these being reported ready for test, and the board is [illegible]vised that the installation of 4 others will be begun [illegible] the near future.

BLOCK SIGNAL STATISTICS.—Under an order issued by the Commission on Nov. 18, 1907, the board [illegible]ared and compiled statistics showing the mileage of railroad operated by the block system in the United States as of

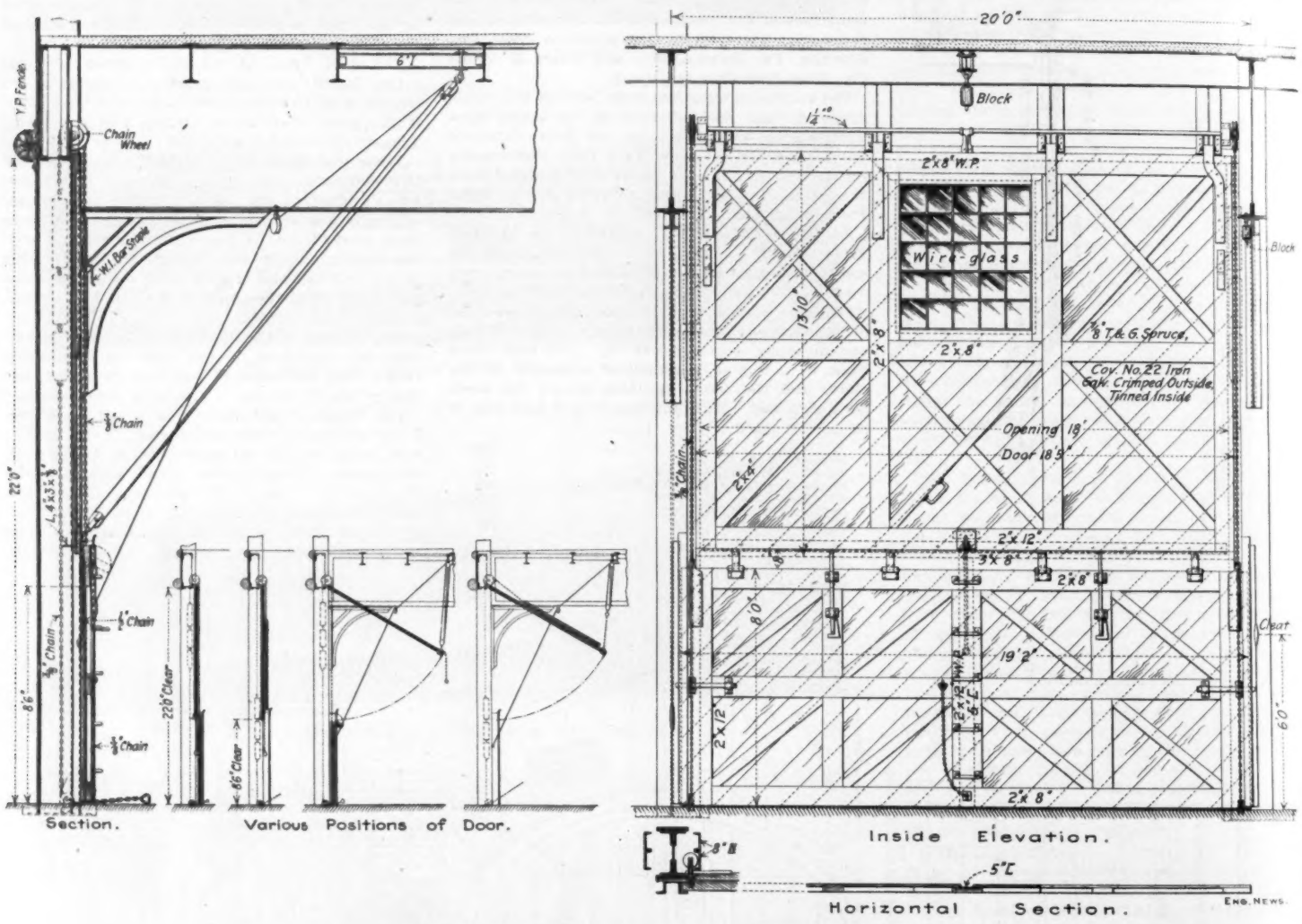


FIG. 11. SECTIONAL LIFT DOOR, CHELSEA PIER-SHEDS.

test of "appliances or systems intended to promote the safety of railway operation."

No tests have yet been undertaken. The work of the board up to the present has been confined to the study of plans and specifications. This phase of the work is only about half completed, and only a few systems or devices have been found sufficiently promising to warrant undertaking tests if an experimental installation should be offered. Nevertheless the board's report is of great interest as a review of the problems before the board and a statement of its experiences during its investigations of signals and safety devices.

Before appointing this special board, the Interstate Commerce Commission itself had investigated the subject of block signaling, reporting to Congress (Feb. 23, 1907) an account of the state of the art in the United States, and recommending legislation looking to the gradual com-

the art. The makers of those automatic stops and cab signals which are in regular use have taken no special pains to bring their apparatus to the attention of the board, though they have offered to furnish any information which we may ask for.

Within the past twelve months a further large number of descriptions of inventions, alleged inventioas, or propositions has been received and they have been dealt with as shown in the statement given below. The authority to investigate devices other than block signals, automatic stops and cab signals, was granted by Congress May 27, 1908, and as yet has been exercised only in a small number of cases, none of which calls for notice in this report. The present status of the work of the board may therefore be said to be as follows:

Plans and specifications of 371 devices have been examined to date. Of these, 248 relate to block signal, cab signal, or automatic train stopping devices, while 123 relate to other devices designed to promote the safety of railway operation, as defined by the provisions of the Sundry Civil Appropriation Act of the first session of the Sixtieth Congress.

Jan. 1, 1908, together with information as to the kinds of apparatus used for automatic block signaling and of the methods employed in the working of the nonautomatic block system, and these were published by the Commission in pamphlet form in April last. By direction of the board, the secretary has distributed 1,500 copies of this pamphlet. Under an order which has just been issued by the Commission, it is proposed to compile similar statistics as of Jan. 1, 1909. These statistics give no information concerning automatic stops, because until within a few months there have been none of these in use on railroads which are subject to federal authority in this matter. (Automatic stops are in use on the Hudson and Manhattan tunnel between New York, N. Y., and Hoboken, N. J.) No information is given concerning cab signals, because none of these are in regular use in this country.

CLASSIFICATION.—The principal appliances or systems, the use of and necessity for which have been considered by the board up to the present time, are the following: 1. Automatic stops. 2. Cab signals. 3. The telegraph block system. 4. The controlled manual block

system. 5. Automatic block system. 6. Railroad appliances and systems not included in the foregoing.

1. Automatic stops.—This term is used to define devices for stopping railroad trains by means independent of the engineman or motorman. The class may be divided as follows:

(a) Contact devices, mechanical, on or near the ground. At a fixed point, as at the entrance to a block section, a lever on the engine or a car of a train, coming in contact with apparatus fixed on the roadway, actuates levers, valves, etc., on the vehicle. No electrical apparatus is used.

(b) Contact rail devices for conveying an electric impulse from a fixed point on the roadway to an electrical apparatus on the vehicle. A rail (or rails) fixed at the signaling point, or in a suitable relation to it (but not continuous throughout the length of the block section), comes in contact with a metallic brush or other conductor on the vehicle.

(c) Ground devices embracing both of the foregoing features.

(d) Devices for making contact overheard, as, for example, from a signal post to apparatus fixed on the roof of the cab of a locomotive, mechanical, electrical, or both.

(e) Devices making no contact, the impulse on the vehicle being produced by magnetic or electric induction.

2. Cab signals.—These may be classified the same as automatic stops, the difference being that automatic stops are designed to shut off steam or cut off electric power and apply the power brakes, or both, while a cab signal is designed only to ring a bell or sound a whistle or show a light for the information and guidance of the engineman or motorman, these audible and visual signals being given in his cab.

3. Telegraph block system.—With this system three principal methods of communication are used: (a) Morse telegraph; (b) telephone, and (c) electric bells (with code). While in the operation of most systems of this kind communication between the signalmen at both ends of the block is prescribed to admit a train to the block, systems are in use on the Erie and on the Northern Pacific in which the operations of the block signalmen are actively participated in by the train dispatcher, who supervises the movement of trains under the block-signal rules throughout a division or subdivision of a railroad.

4. Controlled manual block system.—In this system, which is further described under a separate heading, four principal methods of control are used: (a) block instruments without track circuits; (b) block instruments with track circuits or track instruments at each block station; (c) block instruments with track circuits throughout the length of each block section; and (d) the electric train staff.

5. Automatic block systems.—In practically all such systems in use in this country the operations of the signals are controlled entirely by the action of the train upon track circuits throughout the length of each block section or by certain conditions affecting the use of the block, such as the continuity of the track rails and the position of swithes. In such systems the signals proper are classified as follows: (a) exposed-disk or clockwork signals; (b) inclosed-disk signals; (c) electro-pneumatic semaphore signals; (d) electric-motor semaphose signals; (e) electro-gas semaphore signals; (f) "light" signals; and (g) other types. Such systems comprise a considerable amount of other apparatus, such as relays, circuit controllers, generators, compressors, motors, batteries, and a large number of other electrical and mechanical devices.

6. Other appliances.—This class includes the following devices: (a) roadway and structures, including rails, ties, switches, rail fastenings and other track appliances, bridges, and other structures and permanent way appliances; (b) equipment, including locomotive, motor and car structures and machinery, such as trucks, wheels, car steps and platforms, brakes and brake rigging, draft rigging, car couplers, hose couplers, and car appurtenances; (c) train signals; and (d) operating systems and methods.

Automatic Stops and Cab Signals.

The automatic stops and cab signals now in use are few in number and do not call for extensive investigation, for their characteristics are known. Most of them are installed in situations free from the troubles incident to frost, snowstorms, and certain other adverse conditions which prevail on railroads generally.

Carrying out what we believe to be the purpose of the resolution of Congress, the object kept in view by this board in this matter is the securing of accurate information concerning the usefulness and efficiency of automatic stops in general railroad service. Experience with stops in subways or in other places not exposed to snow, rain, and frost does not afford the lessons sought, and therefore the board is devoting its attention chiefly to such devices as are offered for test in unprotected situations during the winter season. Experience on city passenger railroads is unsatisfactory also because of the absence of some of the conditions which must be met on ordinary railroads, such as irregularity in the length of trains and differences in design of engines and cars; also because in consequence of the very heavy traffic on those lines very frequent inspection is practicable. On ordinary railroads such highly efficient inspection would probably be excessively costly.

AUTOMATIC STOPS.—The principal automatic stop devices which have had our attention are as follows: The mechanical trip devices used in connection with electro-pneumatic block systems in use on the Boston Elevated, the Interborough Rapid Transit of New York City (subway), the Philadelphia Rapid Transit, and the underground lines in London, England. Mechanical trip train stops of the same general design, but worked by electric motors rather than by compressed air, are in use on the Hudson and Manhattan tunnel under the Hudson River between New York, N. Y., and Hoboken, N. J. The officers of these roads are unanimous in their testimony as to the satisfactory operation of the stops, and there have been occasions when but for the action of the automatic stop collisions would have occurred in consequence of neglect on the part of the motormen.

Two experimental installations of automatic stops have been made recently, one of the mechanical trip type, with certain modifications, by the Rowell-Potter Safety Stop Co., on the Chicago, Burlington & Quincy R. R. near Chicago, and one of the intermittent contact rail type, with a normally closed engine circuit, by the Simmen Automatic Railway Signal Co., of Los Angeles, on the Atchison, Topeka & Santa Fe R. R. in southern California.

The Rowell-Potter Co. has been before the public for fifteen years or more and devices made by it have been in use in past years to some extent, notably by the elevated roads of Chicago, but the apparatus now installed on the Chicago, Burlington & Quincy has been tried but a short time, and the board is not yet prepared to report on it. The Simmen devices include a system of remote control of a number of signals in a block system from a central point, such as a dispatcher's office. This installation also has been in use but a short time, and no detailed investigation of it has been made.

The board has made a partial test of the Perry-Prentice cab-signal and train-stop device as recently installed experimentally on the line of the Suburban Railroad Co. of Chicago. This system forms, so far as known, the first application of the use of the Hertzian waves to railroad signaling. It makes use of "wireless" communication between a line wire strung along the track and apparatus in the engine cap. A coherer is included in a normally closed engine circuit, which circuit is broken if the particles of metal in the coherer cease to be held in cohesion by the action of the Hertzian oscillations emanating from the aerial conductor extending through the block.

CAB SIGNALS.—While, as previously noted, a number of installations of automatic train stops have been made on certain city railroads in this country, none of these installations provide for a visible or an audible signal indication on the vehicle. The automatic stops are used in connection with fixed visual signals only, it being generally assumed by the officers of these roads that it is unnecessary to supplement the indication of the fixed signals with any indication on the vehicle, and that the motorman, guided by the fixed signal indications, will properly control his train under all conditions except those which incapacitate him for proper action, in which event the automatic stop will come into play and control the movement of the train. On the other hand, the European idea seems to be that if a sufficiently clear and reliable indication is given to the engineman he can be depended upon properly to control his train; and therefore automatic stopping devices are not favored.

Most of the descriptions of automatic train-stop devices submitted, however, provide for the use of a cab signal; and some cab-signal devices have been presented which do not include the use of an automatic train stop. The immediate problem in either of these devices is to produce certain effects on apparatus carried on the vehicle by the existence of certain conditions upon the track, and if the apparatus or system provides a proper means for carrying out this object the means are equally available for the control of an automatic train-stop or cab-signal or other device of that character fixed on the vehicle.

The only cab signals which have been used regularly for any considerable length of time are: (1) That used on the Northern Railroad of France; and (2) that on the Northeastern Railroad of England. That on the Northern of France is an electric contact apparatus. It is used in connection with fixed manual visual signals throughout the lines of that company, over 2,400 miles in extent, and has been so used on most of those lines for twenty years. A whistle is sounded in the cab of the locomotive when a fixed distant (visual) signal is passed at "caution." The system cannot be approved, however, because the electric apparatus is arranged on the open-circuit principle. As the silence of the whistle in the cab indicates a clear track, any derangement of the apparatus, for example the accidental breakage of a wire, would produce a false clear indication. The apparatus being arranged on this principle, there is no way of knowing with exactness how well it has served its purpose, for it may have been out of order an unknown number of times without being promptly discovered.

The board has communicated with the officers of the Northern Railroad of France, but their experience is relatively of little value as throwing light on the problems which have to be met in this country, because of the open-circuit feature and because in the climate of France the apparatus is not subject to severe weather conditions.

The cab signal on the Northeastern of England is a mechanical arrangement (class 2 a) and it has been in limited use for ten years. Like the electric device just mentioned, however, it gives no warning of its own failure, and therefore the records of its service are of little value as throwing light on the degree of perfection with which it has worked.

A cab signal combining the functions of both classes —2 a and 2 b—but operated on the closed-circuit principle, is in use on the Great Western Railway of England, where it has been in regular service on a short branch line for over a year. This apparatus gives proceed indications as well as caution indications, and the Board of Trade has permitted the abandonment of the fixed distant block signals where this system is in use.

A cab signal actuated by magnetic induction was tried on the Manchester, Sheffield & Lincolnshire several years ago, and with good results, but the experiment was given up because, in consequence of the number of foreign locomotives running over the line, the company concluded that no cab signal of any kind would be desirable.

It will be observed that automatic stops are in use in America, but not elsewhere, except on the London underground lines. Cab signals, on the other hand, are in use in England and France, but not at all in America.

In considering the characteristics and use of automatic stops as compared with cab signals, we have the following facts:

1. Automatic stops have been adopted for regular service only on city railroads which carry a heavy traffic and are worked by electric power. Their lines are in tunnels protected from snow, or on elevated structures where snow does not accumulate in troublesome quanti-

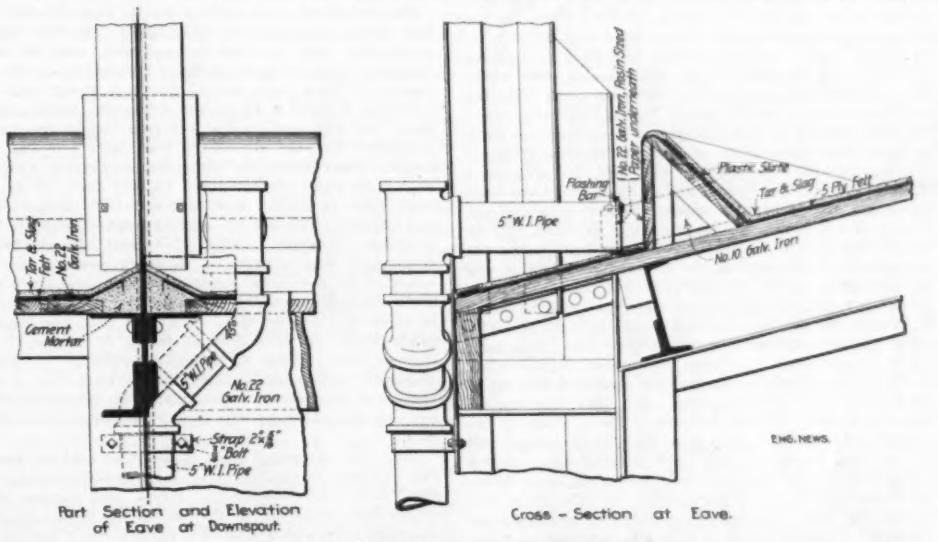


FIG. 12. EAVE GUTTER ON PIER-SHEDS.

ties. Motormen do not have a companion or monitor in the cab with them, as does the engineman of a steam locomotive, and there is therefore a stronger argument for an automatic stop. Being worked under exacting conditions, these city roads are very efficiently inspected.

2. The Northern of France uses cab signals, but it does not get from them the full benefit of which they are capable, and therefore France must be left out of the account.

3. Leaving out facts 1 and 2, both automatic stops and cab signals are to be looked upon as still in the experimental stage, although they have been proposed for many years. Cab signals have been tried in many places, but all of the experiments have been short-lived, except that on the North Eastern of England. British railroad officers naturally prefer a cab signal, because, with the high efficiency of their locomotive runners, they do not feel the need of an automatic stop. They have more trouble from fog than is experienced in America, and therefore feel a more definite need of a cab signal for use as a convenience in ordinary working, regardless of the question of safety. In America both cab signals and automatic stops have been proposed as safety devices purely, and on the assumption that the vigilance of enginemen and motormen can not be improved to the point of insuring a satisfactory degree of safety while using only the present visual signals.

Telegraph Block System.

In connection with the falling off in freight traffic throughout the country since the beginning of the depression in business in October, 1907, some roads have carried their economies so far as to discontinue the use of the block system where it had been regularly maintained for some years; and this expedient is reported to have been adopted on two single-track lines where the controlled manual system (without track circuits) had been in use several years. Again, on lines where the block system is still maintained a part of the block stations have been closed to save the expense of maintaining signalmen both night and day. In still other cases a part of the block stations on a line have been put under new schedules under which they are closed a part of the time; as, for example, an office will be closed eight hours out of twenty-four, thus saving the expense of one signalman. In some cases an office will be kept open in the daytime and not at night, while perhaps at the next station no signalman will be found on duty in the daytime, but one will be on duty at night. Other odd arrangements or hours have been introduced. These irregularities have been introduced not alone because of the depression in business, but also because of the law enacted by Congress March 4, 1907, limiting the hours of service of block signalmen, which increases the expense. As business improves the block system will be restored probably; but this making of extensive changes in the methods of train operation by so many roads emphasizes the importance of the bill which was before the last Congress to authorize the Interstate Commerce Commission to secure full information regularly concerning this department of railroad operation. This feature of the bill introduced by Hon. J. J. Esch, of Wisconsin, in the last session of the Fifty-ninth Congress is no less important than that making the use of the block system compulsory.

As was remarked in the report of the Commission on the block system in February, 1907, many block signalmen in America are young and lacking in training and experience. This has been indicated in the records of railroad accidents, this deficiency being a cause of disastrous collisions. This fault in the personnel of railroad operation has not been so conspicuous during the past year as it was during the heavy traffic of 1905-1907, because, first, the diminished number of trains has made the work of the signalman simpler and easier, and, second, the same cause has made possible the improvement of the block-signal service by eliminating the less competent signalmen. This improvement in the personnel has not been universal, however, and the board has information of instances here and there of signalmen whose incompetence was manifest, and in some of these cases there has been evidence of excessive use of intoxicants. The information the board has gained as the result of the investigation it has conducted along these lines justifies the continuance of this investigation.

While on the subject of the personnel of telegraph offices, it is proper to observe that the difference in habits, capacity, and training of signalmen on the railroads of Great Britain as compared with those of American roads, which was referred to in the above-mentioned report, was confirmed by the observations of members of this board in England and Scotland last spring.

Under the head of the telegraph block system, mention should be made of the superiority of the block telegraph instruments used in England—which are modifications of the well-known needle telegraph—as compared with the communicating methods used with the simple manual or telegraph block system in this country. With the needle system the receiving instrument gives a visual as well as an audible signal, and the visual part, by the position in which it remains after each operation, serves as a constant indication before the signalman's eyes of what the last operation was.

A modification of the telegraph block system has lately been introduced on the Northern Pacific Railway—single track—which merits attention. This is the simple telegraph block system, but each operation by the signalman—or, rather, the series of operations by which a signalman assures himself that a block section is unoccupied and then gives the proceed signal to a train—is carried out under the immediate supervision of the train dispatcher, all the block-signal stations of a district being on a single wire connected with the dispatcher's office. This system is commonly called the "A B C" system. A train is admitted to a block section only on a signal in which the dispatcher and two block signalmen have cooperated, thus greatly reducing the chances of error. The operations are further safeguarded by requiring each train to stop at every station, unless the signalman both displays a clear signal and delivers written cards to the engineman and the conductor. (By means of large hoops these cards are delivered to trains passing at 25 miles an hour and faster.) By the employment of these safeguards provision against collisions of trains is so fully secured that the officers of the road have felt warranted in the discontinuance of the rule requiring all meeting orders to be written out, telegraphed, repeated, and receipted for. This writing and repeating process is so slow that it causes many delays to trains. On some divisions of the Northern Pacific the freight trains are now run over the road in 20 to 25 per cent. less time than formerly. This not only effects an economy for the road, but also enables the trainmen to earn more wages per hour.

The arrangement of meeting points without using the full written and repeated telegraphic orders is equally practicable with the electric train staff, and the same saving in time is accomplished. This is shown by the results on those parts of the Southern Pacific and the Atchison, Topeka & Santa Fe, where the train staff is used. The difference in the Northern Pacific practice as compared with the use of the staff system is that the method under which the dispatcher cooperates with the signalman may be introduced on any line, no matter how light its traffic, and with but little preparation; and the cost of the electric staff apparatus, which is considerable, is saved. On the other hand, the number of dispatchers may have to be increased, and the maintenance of the discipline necessary to make the three-man block signaling operation satisfactorily free from liability to error is probably more of a task than the maintenance of the same degree of safety by means of the electric staff, which is a highly efficient "controlled manual," apparatus for single-track lines. As a preventive of false clear block signals, this apparatus theoretically should be superior to any number of cooperating men.

The term "telegraph block system" as used on American railroads is applied to all man-operated system not fitted with electric control of levers, and includes lines where the telephone is the means of communication. Telephones have been used to a limited extent for several years for sending train orders. They have lately been introduced quite extensively in block signaling, however, as was shown by the block-signal statistics published by the Commission in the present year.

Theoretically, telephones are as safe and as convenient as the long-used Morse telegraph, and the experience of many roads for the last year or two has confirmed this theory. We touch upon this subject in this place merely to make reply to the query, voiced in several places, whether the change in apparatus and methods has involved any lessening of safety. The only serious question that has ever been raised concerning the safety of telephones is in regard to the liability of indistinct transmission of syllables and words. In the Morse telegraph or any other system this contingency must be provided for, and with the telephone, as with the telegraph, mistakes are guarded against by good training and discipline, and by repeating back all communications.

Controlled Manual Block System.

Within the last four years controlled manual apparatus without track circuits has been introduced extensively on single-track lines of the Illinois Central, the Chicago, Burlington & Quincy, and the Chicago & Eastern Illinois railroads, and the electric train staff, embodying similar principles, has been put in use on 100 miles of the Southern Pacific.

As a safety device, the controlled manual system is already well understood and well developed, so that the investigation of it can not be looked upon as calling for special attention on the part of this board; but these extensive installations on single-track lines are in some respects new departures in American railroad practice, and a study for the purpose of comparing these with each other and with other systems may be desirable at a later date.

Automatic Block Signals.

As shown by the statistics which have been published by the Commission, the railroads of the country made comparatively rapid progress in automatic signaling for several years up to the end of 1907. Since then only a few important new installations have been l[illegible]; but within the past month the St. Louis & San [illegible]ancisco gave an order for the equipment of 712 m[illegible] of its single-track lines, and the Southern Pacific is [illegible]suming work on some of the installations which were [illegible]pended a year ago.

The extensive installation on the New York [illegible]ntral & Hudson River in and near New York City of [illegible]omatic block signals adapted for use in connection wit[illegible]ailroad tracks, the rails of which are traversed by [illegible]werful electric currents used with electric propulsion [illegible]rains, constitutes one of the notable instances of pr[illegible]ss in the signaling art.

Lack of Knowledge of the Art.

Of the hundreds of descriptions and plans of [illegible]evices or systems for the promotion of safety in railroa[illegible]peration examined by the board so few possess any merit that it is evident that a large proportion of the inventors or proprietors of such devices are entirely unfamiliar with the conditions to be met in railroading, the development of safety appliances, the state of the art of signaling, and often with well-known natural laws. This is manifested in three forms:

(1) In devices which, no matter how well designed or constructed, would be dangerous or of little or no value.

(2) In devices or systems which, no matter how well the details of design and construction were carried out, are fundamentally wrong in principle.

(3) In devices or systems which, while theoretically useful and workable, are designed without regard to the well-known properties of materials or a consideration of the quantitative values of the forces and velocities involved.

As an example of the first class may be cited the highway crossing gate designed to be closed automatically by the approach of a train. It is obvious that such a device, no matter how perfect in operation, would be unsafe to use as the gates would descend or close when the train was within a given distance of the crossing, irrespective of whether or not pedestrians or vehicles were on the crossing, thus preventing their escape from the very danger that in the invention is intended to avert. Other inventions of substantially the same class are those for the automatic throwing of switches by train approach; especially those intended to restore to the main track position by the passage of the train itself a switch that has been maliciously or carelessly left set for a siding or turn-out.

The most typical devices of the second class referred to, namely, those that are wrong in principle, are signals that require the application of power to move them to the position to indicate "stop," and assume the "proceed" position by gravity or whenever the application of power to them ceases. Within this class falls also the large number of electrical appliances designed to operate on the so-called open-circuit principle. In these, the presence of electric current in the operating devices is required to give a "stop" indication or apply the brakes or accomplish the purpose for which the device is designed; whereas it is evident that all such appliances should be constructed on a principle directly opposite, namely, the closed-circuit principle, so that if the current supply should fail or a wire should break or become disconnected, or a short circuit or a cross should occur, the "stop" indication would be displayed or the brake applied, or other purpose of the design carried out. In other words, all devices or systems must be to the highest degree self-checking of their own failures, so as to render them as nearly as possible incapable of falsely indicating safety when danger exists, or if used in train control, incapable of permitting a train to proceed when it should be stopped. This principle is fundamental and no devices or systems designed on the contrary or open-circuit principle can be approved.

In the third class, or impracticable devices, we find many where it is intended to operate signals or mechanical trip train stops through the medium of cables or rods several thousand feet or a mile or more in length attached to treadles or other trips which are intended to be depressed or moved by engagement with some part of another moving engine or train, little idea evidently being entertained by the inventor as to the inertia of the parts, the effects of impact, the elasticity and strength of the materials employed, or the conditions due to accumulation of snow, ice, or sand.

Reliability.—Next to safety, reliability is the most important feature in safety appliances. By this is meant infrequency of failure of the device or system to respond to all the conditions under which it should act. For example, if a signal device indicates a clear track when the track is obstructed it is an unsafe device. If it indicates danger when there is no danger it is not reliable, and such unreliability soon becomes a source of danger, for if a signal, for example, frequently indicates "stop" when the conditions are all right for the train to proceed, its "stop" indication soon becomes discredited as a true indication of danger and may come in time to be disregarded even when correctly given, and hence lead to disaster.

Contact Devices.—Many devices or systems have been examined in which contact plates or rails are included in

electric circuits carrying current which either continuously or intermittently is intended to be picked up by a contact brush or shoe on the moving vehicle. While a number of such systems are designed on theoretically correct principles, the practicability of making or maintaining a reliable contact can be determined only from long-continued experiment with various forms of roadway and vehicle contacts under such conditions of speed, vibration, clearance, shock, snow and ice as exist in actual railroad working in all localities and at all times of the year. In considering any closed circuit arrangement which makes use of a continuous contact rail it must be borne in mind that a momentary loss of contact which might occur from very slight accidental circumstances might in an automatic train-stop device cause an emergency application of the brakes while running at high speed. This makes the reliability of such schemes extremely doubtful.

Equipment and Structure Clearances.—Inventors or designers of cab signals and automatic train stops often disregard the very definite relations that must necessarily exist between the dimensions of cars and engines and those of platforms, bridges, tunnels, road crossings, and other structures along the roadway. It should be remembered, for example, that the location of end ladders on freight cars must be definite and reasonably uniform in order to make their use safe for trainmen. Yet many devices of the overhead type are presented, by the use of which freight trainmen would undoubtedly be subject to more danger than the use of the devices would prevent. The question of equipment and structure clearances should be carefully studied by all who approach this problem.

Continuous track circuit.—A number of block signal systems have been presented for the board's consideration which involve the use of much complicated apparatus and would doubtless cost as much to install and maintain as the best-known systems now in use, and yet lack the very desirable protection afforded by the use of continuous track circuits with their ability to detect broken or removed rails. This is a protective feature free to be used by any one as far as patent rights are concerned, and it is especially desirable in view of the relatively poor quality of most of the steel rails now on the market.

WORK OF RAILROAD ASSOCIATIONS.—The Railway Signal Association during the last year has had the question of automatic train stops and cab signals under consideration by a committee which presented a report at the annual meeting of the association at Washington in October. This report, in addition to reviewing briefly the history of experimental installations of such devices in this country and describing various systems, submitted for adoption by the association a list of requisites of installation to which automatic stop and cab signal systems should conform to be considered safe and reliable in operation. [See Eng. News, Oct. 29, 1908, p. 465.]

While this list of requisites has not been formally adopted by the Railway Signal Association, and while the board is not prepared to discuss the proposed requirements in detail on the basis of its present knowledge, it feels that they should have the careful consideration of all who are interested in this subject.

While the action of the American Railway Association in restricting the freedom of action of the voluntary technical associations composed of officers and employees of the railroads forming this association may result in a greater harmony and economy of effort by the technical associations themselves, such restrictions will hardly tend, unless exercised with greatest care, to increase the effectiveness of the associations in the promotion of the safety of railway operation.

COMPLAINTS.—No small portion of the correspondence of the board has had to do with complaints and demands for an investigation of alleged suppressions of important inventions by powerful corporations and associations to the serious detriment of the public interest and great pecuniary harm to individuals. The nature of the charges made indicates a necessity for investigation to determine whether they are justified in fact, it being considered equally important from the standpoint of the public to establish definitely that such accusations are untrue as that they are true.

There appears to be a very general belief that the inventor without means or influence cannot get his inventions considered by railroad officials, and in consequence appeals by such inventors to the Government for aid to secure what is believed to be his rights have been both frequent and insistent.

The legislation under which the board acts, while providing the machinery for investigating the use of and necessity for block-signal systems and appliances for the automatic control of railroad trains and other appliances or systems designed to promote the safety of railroad operation, does not provide for the investigation of alleged suppressions of inventions, although it does indirectly aid the inventor without means or influence to get his invention considered when it has been found to possess sufficient merit to warrant a favorable report by this board.

It is believed to be in line with good public policy to provide means to satisfy the insistent demands for just treatment of the inventor, if such means do not already exist, and if they do, then to point out the way to make such means available and effective so as to satisfy the reasonable demands of the complainants.

RECENT DEVELOPMENTS.—Among the more recent developments which are engaging the attention of those interested in the subject of railway signaling are alternating current track circuits for electric roads, working without the use of insulated joints or inductive bonds, the transmision of signal indications by Hertzian waves or other oscillatory impulses, and the production of effects upon moving vehicles as the result of conditions existing upon the track by magnetic or inductive effects without mechanical or electrical contact, involving even such principles as the nonmagnetic properties of manganese steel rails.

European Practice.

Two members of the board, Messrs. Ames and Adams, were named a committee to visit Europe and study what has been done there in applying fixed block signals, cab signals and other railway appliances in the scope of the Board's work. A detailed account of their trip and their observations in England, Scotland, Belgium and France is appended to the Board's report, but only their chief conclusions can be reproduced here.

Briefly summarized, it may be said that the committee found very few automatic fixed signals in use. Several forms of cab signal have been developed, but only one is promising as concerns the application to America. The oldest is the one already mentioned in the body of the report, a system used on the Chemin de Fer du Nord as an auxiliary to fixed signals. It is installed on the entire line of over 2,400 miles (about 2,000 installations) and governs all train movements. It operates by communicating an electric impulse to the engine through a movable contact on the track, set up or down by mechanical connections from the fixed distant signal, and is of the open-circuit type, i. e., the clear indication is merely the absence of a danger signal, and therefore a clear signal is obtained in case of failure of apparatus or current. The system is inapplicable to American conditions on this account.

A cab signal recently developed on the Great Western Ry., in England, seems to the committee to have much promise. It has been installed on the 22-mile single-track Fairford Branch, and worked so well that the Board of Trade gave the railway company permission to discontinue fixed distant signals. The line now operates with fixed home signals under the electric train-staff system, and cab signals in place of the distant signals. The committee describes it as follows:

The system provides for a battery in each cabin, one side of which is grounded and from the other side of which a wire leads through a circuit controller which is closed only by the pulling off or clearing of a lever in the cabin corresponding to the distant signal lever. This wire is carried on the pole line along the roadway to a contact rail or ramp placed midway between the running rails at any desired distance from the home signal, being located approximately in the position where a fixed distance signal would be placed if used. The ramp consists of an inverted T section, insulated from supporting chairs by wooden blocks, the inverted T forming a type of construction offering little surface for the accumulation of snow or ice. The engine equipment consists of a battery from which current is normally supplied to a magnet, the circuit including a switch mounted on one end of a contact shoe beneath the engine in such manner that when the engine is not passing over a ramp the contact shoe is normally in position to close this switch, thus keeping the controlling magnet on the engine normally energized on closed circuit. When the contact shoe mounted beneath the engine engages the incline of the ramp or contact rail, the shoe is raised from its normal position, this movement accomplishing two purposes, first, to break the normally closed engine circuit, and, second, by making electrical contact with the ramp to pick up current therefrom to energize another controlling magnet on the engine, should the ramp be energized from the battery in the signal cabin by the closing of the contact controlled by the proper lever, this circuit being completed through the grounding of one side of the engine controlling magnet just mentioned.

It will be seen from this arrangement of apparatus and circuits that normally the clear signal is maintained upon the engine while running, and that if the conditions are right for the train to proceed the caution indication will be suppressed at the distant signaling point. In order, however, to give a positive proceed signal instead of simply suppressing the caution signal at this point, a polarized relay is provided for the control of the clear indication, which indication consists of the ringing of a bell. In the circuit of the second engine magnet, previously described, is one winding of the polarized relay. When the current is picked up from the ramp, it will, in addition to energizing the engine magnet referred to, also energize the polarized relay, the armature of which will close a local circuit embracing an electric bell and the battery therefor. The second winding of the polarized relay is for the purpose of keeping the local bell circuit closed so that the bell may continue to ring from its local battery after the shoe has passed off the ramp and until the bell circuit is momentarily opened by the engineman operating a break push button. In the circuit of the engine-controlled magnet, first described above, namely, the magnet which is energized from the engine battery itself, is a device controlled by a steam-operated valve so arranged as to open the circuit when the boiler pressure falls to about 20 pounds, insuring the automatic disconnection of the main engine battery in order to prevent the waste of current when the engine is not in running condition. The engine-controlled magnet referred to is used for the control of an air-whistle valve, which sounds the caution indication whenever the engine circuit is broken.

All the apparatus appears to be well designed and the system is exceedingly simple. It is, of course, correctly designed, from the electrical standpoint, being not only on the closed-circuit principle, but having the source of energy of the external circuit located in the cabin instead of on the engine, which provides protection against crosses and grounds.

The principles embodied in the design of this system and a number of its details are believed to be of such merit that the board is arranging a test of an American system designed on practically the same lines.

With respect to the rest of European practice, the committee found that little could be learned therefrom for utilization in the United States. As already noted in the report of the Board, it considers the manual block instruments used in England, which are of the indicating needle type, to be superior to Morse telegraph instruments as used in the telegraph block system in the United States, for the reason that a visual indication is received by the operator and remains in sight until the next movement. Aside from this detail, the points noted by the committee as commendable are stated in their concluding paragraph, as follows:

In conclusion the committee desires to state that so far as signal and safety appliance apparatus is concerned it believes that little is to be learned from a study of European railways. Of the cab signal devices in use on English railway and forming the chief object of the committee's investigation only one, namely, that of the Great Western Railway, is believed to be worthy of consideration. On the other hand, many of the methods employed are most praiseworthy and if adopted in this country would, we believe, tend to promote the safety of railway operation. Chief among these methods or practices are:

(1) The careful selection and thorough training of block signalmen.

(2) The thorough inspection of manual block signal methods.

(3) Proper inclosing of railroad rights of way, together with the enforcement of laws against trespassing thereon.

(4) The establishment of pension systems by railroad companies for their employees.

(5) The compulsory use of a space interval in train operation.

(6) More complete governmental supervision of railroad construction, maintenance, and operation.

HYDRAULIC DREDGING FOR 1¾ CTS. PER CUBIC yard was done in the Delaware River last fall by the government suction dredge "Delaware." Between Oct. 1 and Nov. 16 the dredge removed 1,148,870 cu. yds. of material, and the cost of operating the dredge during this period of time, including wages, subsistence, fuel and other supplies and current repairs, amounted to $10,650,000, showing a unit cost of less than 1 ct. per cu. yd. The allowance for depreciation of plant and annual repairs brings the total cost per cu. yd. up to about the figure stated above. In view of the statements frequently made regarding the excessive cost of work done by the government direct, compared with work done by contract, these figures are of especial interest. The dredging of the Delaware is being done under the direction of the United States Engineer Office in Philadelphia, the officer in charge being Major Herbert Deakyne, Corps of Engineers.

A SUBSTITUTE FOR LIGNUM-VITAE has been found in the forests of the Philippine Islands, where it is known as Mancono. The botanical name is Xanthostemon verdugonianus, Naves. This wood is said to be practically impervious to decay and the attack of insects and to have a specific gravity greater than unity. The heartwood of the tree is reddish black, turning to a black walnut color after several years of seasoning, and takes a high polish. A bulletin of the Philippine Bureau of Forestry, from which this information was obtained, makes the following announcements:

(1) The Philippine forests possess a tree whose wood, for at least some of the practical purposes required by the lumbermen in America, is equal to that of the rare Lignum-vitae. It is probably even harder though a trifle more light.

(2) It is found in merchantable sizes and quantities in areas of sufficient extent to warrant its exploitation, and with proper care in cutting the supply may be made to last indefinitely.

(3) It grows in places immediately accessible for cutting and the difficulties of transportation encountered in exploiting many Philippine woods are minimized.

(4) The wood has been used in shipbuilding as a substitute for Lignum-vitae at the United States Naval Station at Cavite, P. I., and the head of the steam engineering department pronounces it a perfect success after a year's trial. It has also been satisfactorily tested in the shipyard of the Bureau of Navigation in Manila.

(5) Most important of all, it can be produced and delivered in New York at a profit, for about four centavos a pound, while the costly Lignum-vitae brings from 20 to 60 centavos (15 to 30 cts., United States currency) for the same amount.

Bituminous Producer Plants, With Recovery of Tar for Fuel.*

By ELBERT A. HARVEY.†

The process used in the plants here described involves the generation of producer gas in updraft producers without any attempt to burn the heavy hydrocarbons or tars into gas in the gas generators, the hydrocarbons being removed from the gas by a mechanical cleaning process carried on in a rotary gas washer, leaving the gas clean and in possession of its light hydrocarbon constituents, and therefore a far richer and more useful gas than can be produced by any downdraft or back draft process in which the tars are burned into gas in the producers.

The apparatus used for this process, which is known as the Industrial gas equipment, includes also apparatus for the recovery and utilization of the tar removed from the gas, deriving from this the power required for the operation of the gas washer and the necessary steam or vapor for generating the gas. The energy of the coal is thus separated into three parts; one in the form of chemical energy represented by the final product, a clean, cool producer gas, and amounting to about 75%; the second in the form of tar and amounting to about 12½%; and the third in the form of sensible heat lost in radiation from the gas generators and carried away by the cooling water, and amounting to about 12½%.

The producer is of the updraft, water-sealed type developed directly from the original Siemens producer, and to-day used in identically the same design (but not in connection with cleaning apparatus) with open-hearth and glass-melting furnaces, and for a great variety of processes requiring raw, uncleaned producer gas.

The rotary gas washer is the direct outgrowth of a type of machinery of which perhaps the most primitive sample is the farmer's churn, the immediate antecedent being the rotary dust cleaner for blast furnace gas which had its development in Germany; and the tar-burning outfit is simply a variation of fuel oil equipment. On the other hand, the application of these various equipments to the production of clean producer gas from bituminous coal involves new features and produces good results.

In seeking, like many others, a substitute in the event of shortage in their natural gas supply, the management of an Indiana glass manufacturing establishment conceived the idea of using some of the raw bituminous producer gas which they were burning in their gas melting furnaces. Their producer equipment was similar to that used in the large glass factories throughout the country, in which the gas is conveyed in large brick conduits 6 to 8 ft. square or in diameter. The gas is under only the slightest pressure and rolls along like heavy smoke depositing the tar and soot. The flues are burned out once a week to free them from the tar and soot.

After some experimenting at home, these gentlemen investigated foreign gas producer equipment, and Mr. Gustave Saaler, a German engineer of reputation, designed a gas-cleaning equipment for their use. To-day the company are operating their gas power plant on producer gas from Indiana and Pittsburg bituminous coal, and developing an average load of 1,320 B. HP. on two Koerting double-acting, two-cycle gas engines, direct connected to two 400-KW. Westinghouse alternating current generators connected in parallel. These engines are rated at 600 HP. each for natural gas, but on producer gas are successfully carrying this overload 24 hours per day, 6 days per week. The present gas power plant of this concern embraces the following equipment:

Four Taylor gas generators, 10 ft. diam., remodelled in 1907 by the Industrial Gas Co. of New York so as to include the Herrick tuyeres.

Two Saaler rotary gas washers, with accompanying coolers and dry scrubbers, installed in 1906-07.

Three 600-HP. Koerting double-acting two-cycle gas engines, operating at 100 r. p. m., direct connected to 400-KW. Westinghouse alternating-current generators connected in parallel, two engines being in constant service with one spare idle unit.

One 150-HP. Westinghouse vertical three-cyl... gas engine, direct connected to direct-current gene... for lighting purposes.

Some gas is used in their rouge ovens (used f... glass polishing), but a tar outfit will be installed in ...

This power plant has been operating for over ... year and has made a complete continuous run du... the year of 1907, 24-hour service most of the time, ... nishing power in a satisfactory way to meet the l... factory conditions. Complete statistics of this p... are not available. The engines are showing excell... economy, averaging 10,573 B. T. U. per B.HP.-hr. ... ever they have not been satisfactory in all particul... and this type of engine has since been withdrawn ... the market by the De La Vergne Machine Co., whose ... sent engines, by the way, are showing considerably bet... fuel economy and better construction in other detail... This company operates two power plants; one, the ga... plant just referred to with its average load of 1,320 H... and an average coal consumption of 15 tons Pittsburg No. 8 three-quarter lump per 24 hours; the other is a steam plant, average load 1,250 HP., average consumption of same coal 75 tons per 24 hours. The two plants present one of the most striking illustrations of the contrast between power plants of this size, both operating under the same factory conditions. This equipment cannot be considered the equal of what could be put in at the present time, but it has been one of the pioneer plants which has done yeoman service in establishing the reputation of the successful continuous operation both of the gas engine and gas producer plant.

While detailed statistics are not furnished for this plant, I am permitted to state that the record for the year 1907 showed a total coal consumption in the producers of 1.34 lbs. of coal per KW.-hr. at the switchboard, equal to 0.9 lb. coal per HP.-hr. on the driving wheels of the engines. These figures, however, do not take into consideration the fuel required to operate rotary washer and furnish steam to the producers, which increases these figures to 1.7 lbs. of coal per KW.-hr. at the switchboard and 1.06 lbs. of coal per HP.-hr. at the engine drive wheels.

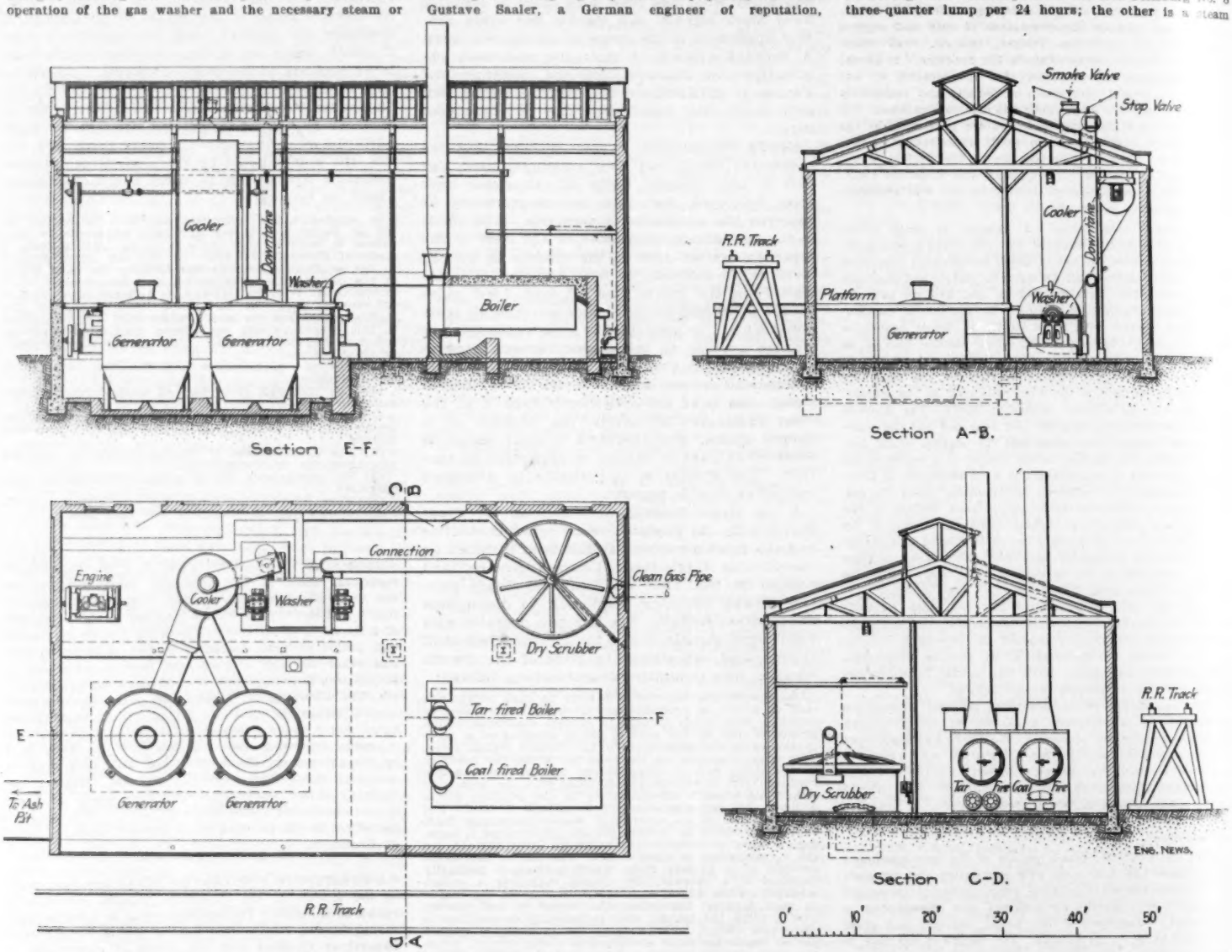


FIG. 1. BITUMINOUS GAS GENERATING AND CLEANING PLANT, 2,000 HP.

*A paper presented at a meeting of the American Society of Mechanical Engineers, Oct. 13, 1908.

†50 Church St., New York City.

The figures for the auxiliary equipment are estimated, and these figures cannot therefore be presented as absolutely authentic, but they are the nearest estimate which I am able to make, and I believe represent the actual conditions. The following figures indicate the probable heat balances representing operating conditions at this plant.

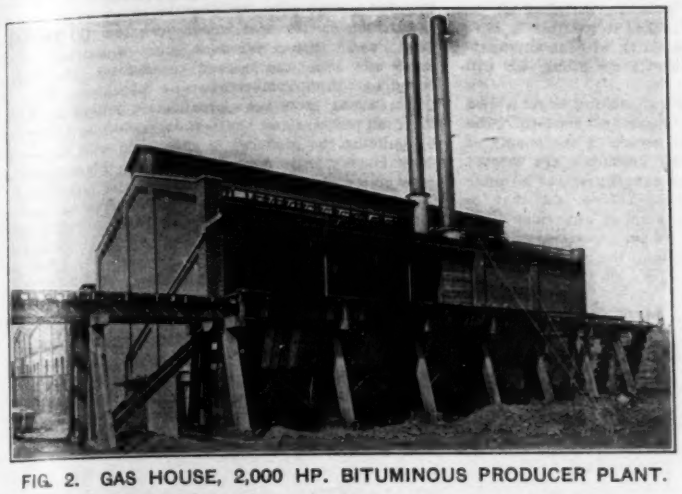


FIG. 2. GAS HOUSE, 2,000 HP. BITUMINOUS PRODUCER PLANT.

PROBABLE HEAT BALANCES IN CONNECTION WITH 1,800 HP. GAS AND ELECTRIC POWER PLANT OPERATING 24 HOURS PER DAY, 6 DAYS PER WEEK, AVERAGE LOAD 1,320 B.HP. AT SWITCHBOARD.

COAL.	
1.06 lb. Pittsburg No. 8, assumed average 14,249 B. T. U. per lb., giving a total B. T. U. per HP.-hr.	15,104
PRODUCER LOSSES.	
(1) Radiation: 10% of heat value	1,510
(2) Tar: 8% of heat value	1,208
(3) Power and Steam for gas making 12% of heat value	1,812
GAS ENGINE LOSSES.	
Engines using 10,573 B. T. U. per B.HP. hr. 51.2% of heat value	7,746
ELECTRICAL GENERATOR LOSSES.	
Assuming 90% efficiency, making 1.9% of heat value	283
Total losses	12,559
One theoretical HP. showing a net power plant efficiency of 16.9%	2,545

TABLE I.—COST OF GAS POWER IN 1907 AT THE FIRST INDUSTRIAL GAS GENERATING AND CLEANING PRODUCER GAS POWER PLANT: 1,800 HP. IN THREE UNITS, TWO OPERATING AND ONE IDLE. SERVICE 24 HOURS PER DAY, 6 DAYS PER WEEK. COST FOR ONE DAY, 24 HOURS.

COAL.		
In producer, 15 tons per day at $2.50		$37.50
STEAM.		
35 HP. for gas washer at 34½ lbs. per HP. = 1,210 lbs. per hr.		
For gas making 415 lbs. per hr.		
This makes approximately 45 HP. per hr. costing say 50 cts.; per day		12.00
WATER.		
3 gals. per HP. hr. in cooler		
2 gals. per HP. hr. in rotary washer		
9 gals. per HP. hr. in gas engine		
This figures 450,000 gals. per day, costing at a pumping charge of 1 ct. per 1,000		4.50
LABOR.		
One head gas man for each day and night shift, superintending the producer men and in actual charge of the gas washers, cooler and dry scrubber, at $2.50	$5.00	
Two producer men for each shift, charging coal, poking producers, and cleaning out ashes, at $1.50	6.00	
One gas engine engineer responsible for engine room both shifts, and in actual charge one shift	3.00	
One assistant gas engine engineer in charge of engine room, night shift	1.75	
Two engine room oilers and helpers each shift, $1.50 each	6.00	
One helper: the coal is brought to the charging platform, the ashes carted away, tar removed, and there is other intermittent work attended to at odd times by various laborers, making the full equivalent of one man's time each shift, at $1.50	3.00	
		$24.75
Oil and waste		3.00
Light and miscellaneous expenses		1.00
Total operating charge per day		$82.75
OVERHEAD COST.		
Assuming a total investment of $100 per HP. for an 1,800-HP. gas power plant, amounting to $180,000, and figuring 15% overhead charge to cover interest, depreciation, maintenance, insurance, taxes and supervision there is a yearly fixed charge of $27,000 or per day		$90.00
TOTAL COST OF 1,320 B.HP. AT SWITCHBOARD FOR ONE DAY, 24 HOURS		$172.75
Cost per KW.-hr. at switchboard, 83/100 cts.		

The actual cost of power for this plant from the company's books is not available, but it is possible to offer fairly accurate figures showing the probable cost of their power based on conditions as they exist. (Table I.) The two principal factors are known, viz., the coal consumption and the number of men employed. The steam and power required for auxiliary equipment can be closely estimated, and other charges are based on standard practice. The figures are made up on the basis of the cost of 1,320 HP. average load during 24 hours for one day.

Some months ago I had occasion to make up carefully figures on a complete gas-electric power plant of 20,000 HP. for 24-hour service, full and steady load, 308 days per year. In Table II. is given the summary of carefully worked up detailed estimates of the cost of equipment and cost of power.

The figures in this table were made up on guaranteed efficiency of 70% for the producer gas engines operating on 10,000 B. T. U. per B.HP.-hr., 90% for the electric generators, and the cost figures are to the extent of 90% based on actual quotations.

The next plant installed was to replace natural gas in small furnaces for tempering, case hardening and light forging. This plant was started in the spring of 1908, and proved a complete success. The gas gave most satisfactory results in all their furnaces, producing heats as high as required with the gas delivered at a pressure of about 3 ins. of water, and air from a fan at slightly higher pressure. No regeneration whatever has been used. This plant has demonstrated that producer gas can be used with entirely satisfactory results for work of this class not requiring high heats. Some test runs have been made here for which heats sufficiently high for forging and welding have been claimed, but these claims have not been demonstrated by actual operation but are based upon judgments formed by the incandescence of the furnace. It is my opinion it will prove practicable to use producer gas of this kind in small furnaces for heavy forging and welding operations, but undoubtedly some regeneration will be required for this kind of work. As yet the point has not been thoroughly tried out, and claims are being made quite generally that producer gas can be used without regeneration or preheating for small furnace welding and melting operations. On the other hand it has been and is still to a large extent the opinion of gas engineers that even if such results can be secured by the use of high pressure air, it would not be economical to do so, and that the cost of equipment for regeneration would be too great to warrant the use of producer gas for this line of work, the conclusion being that producer gas cannot compete with high temperature gas such as water gas or natural gas in this field. The firm with which I am connected hopes within the near future to demonstrate this point in connection with gas of this kind under actual shop operations.

FIG. 3. CONCRETE CHARGING PLATFORM, 2,000 HP. BITUMINOUS PRODUCER PLANT.

TABLE II.—ESTIMATED COST OF COMPLETE 20,000-HP. ELECTRIC POWER PLANT, INCLUDING EVERYTHING UP TO CONNECTIONS FOR THE DEPARTING SERVICE WIRES.

Gas engines and electric generators	$780,000.00
Gas producers and auxiliaries	200,000.00
Building	60,000.00
Miscellaneous, including piping, pumps, exciters, freight, etc.	60,000.00
	$1,100,000.00
COST PER HP. OF EQUIPMENT, $55.00.	
ESTIMATED ANNUAL COST OF ELECTRIC POWER AT THE SWITCHBOARD, 20,000 HP., FULL CONTINUOUS LOAD, 24-HR. SERVICE, 308 DAYS PER YEAR.	
COAL.	
For entire equipment, bituminous run of mine, at 1¾ lbs. per KW-hr. at switchboard, amounting to 84,000 tons at $2 per ton	$168,000.00
LABOR.	
Including chief and assistant engineers for both shifts, and all necessary assistants, amounting to 40 men	$28,800.00
Oil, waste and miscellaneous supplies	24,000.00
Overhead charges at 15% on $1,100,000	165,000.00
Total cost of 95,000,000 KW	$385,800.00
Cost per KW.-hr. at switchboard, 4/10 cts.	

In giving the heat value of the gas a minimum standard is adopted, viz.: the gas is taken at 62° F., 14.7 lbs. pressure, and that portion of its heat value represented by the latent heat of the steam formed from the hydrogen and the hydrogen in the hydrocarbon is discarded. Without these subtracted, the heat value of the gas at the same standard of temperature and pressure would be 156 B. T. U. per cu. ft. This is excellent gas, and about the average for gas made in this process. It is considerably better than the gas made from poor slack coals which average from 120 to 130 B. T. U. per cu. ft. and not as good as the gas made from lignite, which will average from 160 to 170 B. T. U. per cu. ft.

This plant has not yet been in operation long enough to establish accurate operating costs but a fairly close estimate of the cost of gas is shown in Table III. made up from the most accurate information I can get.

Description of Producer Plant.

This 2,000-HP. plant, which was the second to be installed, is a complete typical equipment, and will serve very well to show the design of this class of apparatus. The accompanying photograph (Fig. 2) shows the gas house. This outside view of the gas house calls attention to a point of first consideration, viz.: coal delivery to the gas premises. An elevated track is shown coming in on a level some 6 or 8 ft. above the charging platform, or working platform on the producer tops. The coal is dumped from bottom dump cars into the bins shown under the track and runs right in on to the charging platform. Another view illustrates this feature, showing two producer tops, each with one coal hopper and a number of poke holes.

COAL.		
Moisture		6.65
Volatile H.c		36.75
Fixed Carbon		50.35
Ash		5.40
Sulphur		Not given
B. T. U.		Not given
GAS.		
CO	21.47 at 324 B.T.U. = 70.	B.T.U.
H_2	15.29 at 278 B.T.U. = 42.5	B.T.U.
CH_4	3.58 at 919 B.T.U. = 33.	B.T.U.
O_2	0.00	
CO_2	8.57	
N_2	5.109	
	100.	145.5

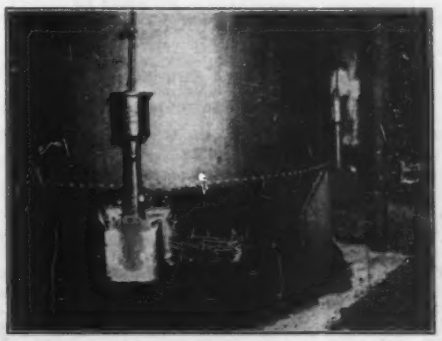


Fig. 4. Herrick Gas Producer, Showing Induction Blower.

CHARGING.—The charging platform is of steel frame work with concrete filling. The producer tops are made up of heavy castings, studded with fire bricks, the bricks projecting down below the lower surface of the metal.

This arrangement affords a strong, cool top which does not require water cooling, and which is sufficiently tight for use with bituminous coal, as the tar in the gas soon fills up all leaks. It should be noted that the wall of the gas house is not built in over the charging platform, leaving this part exposed to the air. This is desirable because some gas escapes while the fire is being poked, making it almost impossible for the men to work where the producers are located in closed rooms. This gas house was designed so as to provide the open or out-door feature for the charging platform and the protected closed power-house for the rest of the apparatus.

In making gas from bituminous coal it is desirable to charge the coal as uniformly as possible for the reason that a large percentage of the fuel value of bituminous coal consists of volatile hydrocarbon represented in the final gas as CH_4 and C_2H_4. This is volatilized by the heat in the producer without any chemical reaction, and is given off soon after the coal is introduced into the producer. This process is quite distinct from the production of CO by the primary producer process of semi-combustion, and in order to keep the gas with approximately the same ratio of these constituents it is necessary to introduce the coal into the producer at an approximately uniform rate. In practice it is found satisfactory both for gas engine and small furnace requirements to charge about once every 15 minutes. For power plant work, where producers of large size are used, 10 or 12 ft. outside diameter, it is necessary to have one man per producer. These men put in the greater part of their time poking the fire to keep it in condition. The poorer the coal, the more poking is required. As these same men charge the coal, no more labor is required on account of this frequent charging than would be required otherwise, and on this account there has been no attempt to adopt automatic coal feeders in connection with this class of apparatus.

The poke holes on these producers are all located on top and quite near the sides of the producer. This makes it possible to scrape the sides with the pokers and avoids the necessity of putting poke holes in the sides of the shells, and makes it possible to have a solid brick lining without any apertures, and therefore a lining that will last.

The entire gas making is controlled from this charging platform. The steam valves governing the supply of steam for the producers are located here, and the quantity of gas is regulated by these valves. All that is necessary to stop at any time is to cut off the steam, open one of the poke holes, light the gas and let it burn until the flame dies out; and in the morning all that is necessary is to turn on the steam which blows up the fire, let the gas escape through all the poke holes for awhile until the quality is seen to be good and then close the poke holes, and gas of good quality with the proper pressure will be found to be in the mains.

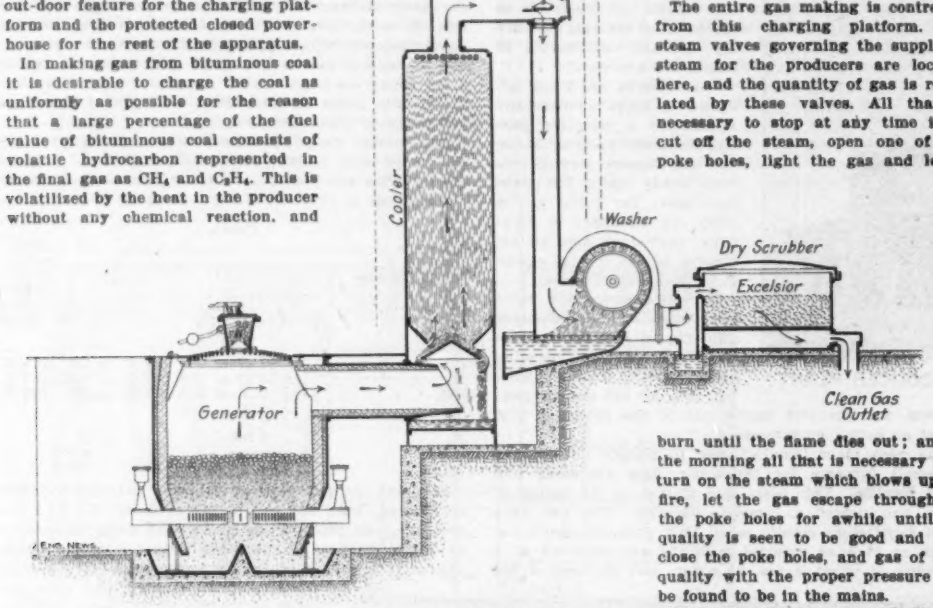


FIG. 5. INDUSTRIAL GAS GENERATING PLANT.

These producers are built as plain brick lined cylinders as shown in Fig. 5, without grates, and with the fuel body resting immediately upon the ash which extends down to the bottom of the concrete water basin below the producer, the producer being entirely open at the bottom, the water forming the bottom. Air and steam for gas making are introduced through tuyeres, or blast boxes, projecting through the sides, the air and steam getting into the fuel through slots in the sides and ends of these tuyeres and being thus distributed uniformly over the entire surface and passing in this way up through the fuel body. The ash is maintained at a level about 1 ft. above the tops of the tuyeres and it is desirable to maintain at least 3 ft. of burning coal above this, but to keep the coal sufficiently deep so the top of the fuel bed does not show very hot, being partially black. The operator soon learns to judge of the condition of his fuel bed and the quality of gas being made by the temperature as seen, and by the appearance of the gas escaping through the poke holes. If gas of a good quality is being made, the fuel bed appears at the right temperature, and the gas is of a decided brown tinge; but if the temperature runs up or down, it means that an excess quantity of air is being introduced and part of the gas is being burned in the producer, raising the temperature, or an excess quantity of steam is being introduced which is lowering the temperature of the fuel bed, and if this continues the fire will soon arrive at a stage where no gas whatever can be made. Any expert gas maker can judge his fire simply by the eye, but these producers are equipped with thermostats indicating the actual temperature in the producer necks, and with U-tube water pressure gages indicating the pressure, so that the operator always has before him the exact temperature and pressure conditions and can regulate his steam valves, coal feeding and poking accordingly.

The distribution of air and steam in these producers is so excellent that very little trouble is experienced with clinkers even with low grade coals, and so far as results are concerned these producers have been just as successful with slack Indiana and Ohio coals as with the best run-of-mine gas coals. However, the poorer the coal, the more labor is required and the smaller the quantity of gas produced, and the selection of coal must be determined by each individual manufacturer after balancing the cost of coal and labor, and frequently it is found that high grade gas coals are the cheapest even when secured at considerable advance in price.

DEVELOPMENT OF THE PRODUCER.—In order to appreciate the significance of the various features of this gas generator, it is well to recollect the development of the producer and just what producer gas is. Producer gas was first introduced by Siemens in England in the 60's. The original producer was simply an attachment to a furnace in a way whereby combustion was carried on at two points, there being a primary and secondary combustion. The idea was to produce semi-combustion in the first chamber by limiting the supply of air so that the carbon in the coal would burn into CO instead of CO_2, and then introduce the remaining necessary air into the second combustion chamber to complete the combustion by burning CO into CO_2. Carbon gives up approximately 30% of its heat in the first process, and the remaining 70% in the second. By building the producer in connection with the furnace there is very little radiation loss, and this arrangement gave pretty close to a theoretical 70% efficiency and accomplished a degree of control and continuous operation not obtainable in a hand-charged furnace, the principal reason for this being that the intermittent charging of the coal into the producer did not seriously affect combustion conditions in the furnace.

The next step in producer construction was to introduce a quantity of vapor with the air. This vapor was decomposed, giving off hydrogen in the producer, and in this way absorbed part of the waste 30% given off by semi-combustion. This recovery of waste heat by the introduction of vapor is so effective that in a number of producers operating in this country to-day, delivering hot gas immediately to the combustion chamber, there is an actual working efficiency of over 90%. Figures of this kind are published by the Morgan Construction Co., Worcester, Mass., on apparently valid authority.

Several Siemens producers and furnaces were imported and operated in this country in the 60's, but the first producer to gain any prominence in this country was a producer manufactured under English patents and placed on the market in this country by the Duff Patents Co., which company is to-day one of the most prominent producer builders in the field. This producer embodied all the points of the original Siemens producer, but added the feature of an open bottom standing in a basin of water, the water forming the bottom; the idea being that the ash could be removed under the surface of the water during operation, thus making it possible to operate continuously without shutdowns. In order to remove the ash in this way during operation, it proved necessary to use grates extending over only a part of the producer area, so that clinkers could be poked down and taken out below the water. This type of producer has for the past 20 years furnished gas to a great proportion of the glass and steel mills. The principal difficulty which has been experienced with the Duff producer was the fact that the distribution of the air and steam was not uniform over the entire area of the fuel bed, and clinkers were apt to form and cling to the grates.

The next step in advance in producer construction was the introduction of the Talbot type of producer now represented by the producers of the Morgan Construction Co., R. D. Wood & Co., and others, which replaces the grate with a central mushroom blower, thus bringing a nozzle for the air and steam right up into the center of the fuel body. This accomplishes very much better distribution than in previous arrangements and has only within the last year or two been improved upon.

The Herrick tuyeres distribute the air and steam more

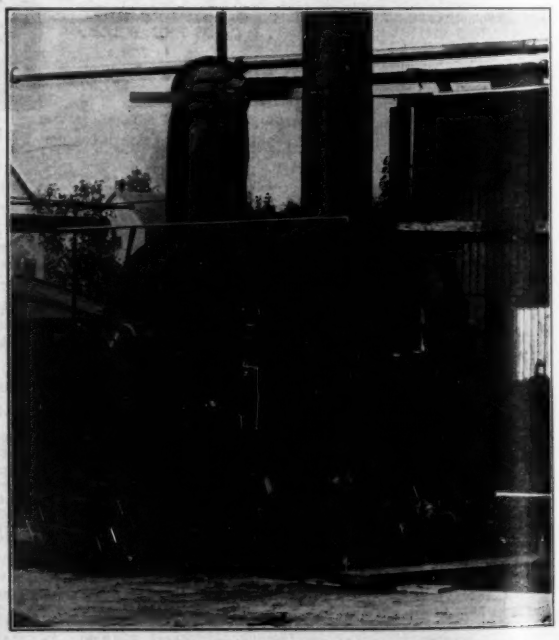


FIG. 6. SAALER ROTARY GAS WASHER, 750 HP.

TABLE III.—COST OF PRODUCER GAS MADE IN 2,000-HP. PLANT OPERATING IN CENTRAL INDIANA, INSTALLED IN 1908.

DAILY COST OF THE EQUIVALENT OF 200,000 FT. NATURAL GAS IN 10 HRS.

COAL.		
Used in producer, Indiana run of mine, Vandalia No. 4: 10 hrs. operation, 17,000 lbs. stand-by losses, 1,000 lbs., making a total of nine tons at $2		$18.00
AUXILIARY FUEL.		
Steam for engine operating gas washer, average load 60 HP., using per hr.	3,200 lbs.	
Producer using per hr.	500 lbs.	
Tar handling and burning outfit per hr.	500 lbs.	
Total steam per hr.	4,200 lbs.	
This amounts to approximately 125 boiler HP. They require when operating on coal only, 6,000 lbs. per day. The tar amounts to approximately 10% in weight of the coal burned, or 1,250 lbs. per day, and each pound furnishes as much steam as two pounds of coal making the equivalent of 2,500 lbs. net coal fired in boilers per day.	3,500 lbs.	
Making 1¾ tons, at $2		$3.50
WATER.		
100,000 gals. per day at a pumping cost of 1 ct. per 1,000 gals.		1.00
LABOR.		
One gas man in charge, and also caring for washer, steam engine, cooler, tar outfit, and boiler	$3.00	
Two and a half helpers: two men on charging platform and the equivalent of half of one man's time for odd work at $2	5.00	
		$8.00
Oil and waste		0.50
OVERHEAD CHARGES.		
15% per annum on an assumed total cost for gas plant, gas house, charging platform, elevated track, furnace and pipe alterations, of $35,000, making an annual charge of $5,250, or per day		17.50
Cost of the equivalent of 200,000 ft. natural gas per day		$48.50

Cost of equivalent of 1,000 ft. natural gas, $0.2425.

completely and the result is less trouble from clinker, increased capacity, and a great reduction in the labor required for gas making. Furthermore, with this uniform distribution it is possible to gasify many low grade coals without an unreasonable amount of labor. These producers are equipped with Eynon-Evans steam induction blowers, four tuyeres, each with a blower, being used on the 12-ft. diameter producers, and three, each with a blower, on each of the smaller sizes. Each blower is supplied with a ½-in. steam pipe, the steam being discovered under a pressure of from 10 to 20 lbs. A pressure regulating valve is placed at a convenient point for adjustment for the men on the charging platform and is adjusted from time to time so as to maintain a uniform gas pressure and at the same time deliver the supply of gas called for. These blowers draw in the air required for gas making by induction, the quantity of air being regulated by an air shutter, and when once adjusted need further adjustment only very occasionally.

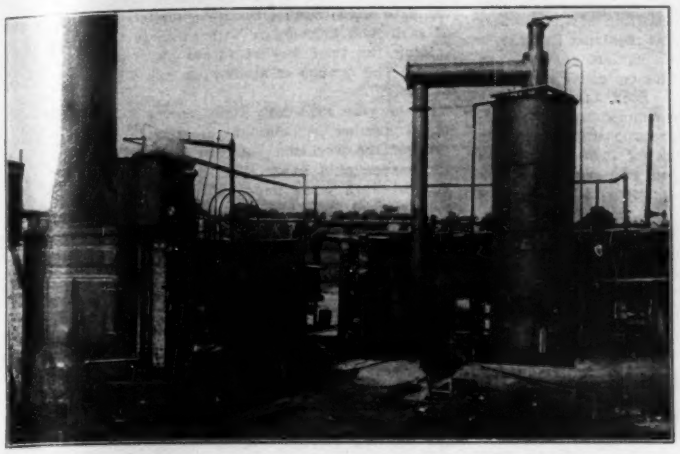


FIG. 7. INDUSTRIAL GAS PLANT, SHOWING AUXILIARY BOILER, WITH TAR FEED TANK.

COOLING TOWERS.—The accompanying sectional cut (Fig. 5) shows a view through the entire producer gas plant. Gas is delivered from the gas generators through brick-lined flues into cooling towers. These are simply large steel tanks built with small diameter and proportionately large height; this apparatus for 2,000 HP. being 8 ft. in diameter and 30 ft. high. They are equipped with water sprinklers, providing for a shower of water passing down and striking against the flow of the gas passing upward. This cools the gas and removes a very small portion of the tar. The cooler has a sloping bottom terminating in a trough. This is arranged in a manner so that the water passes out at one level, the light tars float on the top of the water and pass off at a slightly higher level, and the heavy tars collect at the bottom where they are drawn off periodically. We are building these coolers now without bottoms, standing them in water basins, the water forming the bottom so as to prevent any obstruction or collecting point for the tar, and so as to facilitate the removal of the tar. The cooler is also provided with several manhole doors at convenient points so that it can be scraped from time to time. It is not yet known just how often this piece of apparatus needs cleaning, but it can be stated, however, for the entire apparatus that there is no part which requires a shut down for cleaning except at long periods, so that a single unit apparatus can be built for continuous 24-hour service every day in the week, provided there are short shut-downs once or twice during the year.

The pipe leaving the cooler is shown with projection, with a cap valve operating with a lever handle. This serves the purpose of a stack and is used to allow the gas to escape when first blowing up the fires, as it is difficult to blow the fire up quickly if only the poke holes are used for this purpose. Frequently this stack is located between the producer and the cooler, or elsewhere than shown here.

ROTARY GAS WASHER.—Gas is conveyed from the cooler to the rotary gas washer. Partial views of this machine are shown in accompanying photographs, and in the sectional view of the entire plant. Primarily this machine consists of a cylindrical drum encased in a shell of the same shape, both drum and shell having steel plate projections which clear by about ½-in. as the drum revolves within the shell. The gas enters the washer at one end and passes out at the other, being whirled along by the movement of the drum, coming in contact with the blades of the drum and the blades of the shell in its passage. Water is introduced into the washer through a series of funnels along the side, is picked up by the blades of the revolving drum, dashed into spray and thoroughly mixed with the gas. The drum is designed and built with such proportions that the tar is thrown out of the gas by centrifugal force. This is facilitated by the presence of the water which cools the tar from a gaseous to a liquid state and forms with it an emulsion which carries it down so it collects at the bottom of the washer while the gas passes out at the end. The washer is built with a fan attachment at the end which pulls the gas through by suction and delivers it under a slight pressure. The shell of the washer is built so as to open into an open tank filled with water, and the tar as it collects floats on the surface of this water and then overflows a similar shield to that on the cooler.

This washer removes the tar from the gas in a way completely satisfactory for engine and furnace operations. The washer is sold under a warranty that the gas will contain not to exceed .015 grains of impurities all told per cu. ft. Approximately 3 gals. of water per HP.-hr. are used for cooling the gas in the cooler and 2 gals per HP.-hr. for scrubbing the gas in the washer. The washer is self-cleansing; that is, there is no tendency of the tar to gum up the parts. It is thrown out as formed and carried off automatically by the flow of water, so that a washer can be installed in a single unit for continuous service, and can be counted on for reliable service.

It is important to maintain these washers uniformly at the correct speed. If speeded too fast, the water is atomized too much and the cleansing process retarded. If speeded too slow, the centrifugal force is reduced and the tar goes through with the gas. In starting after shutdown at night, the washers require from 25% to 30% overload above that required during normal operation. For this reason either a steam engine or electric motor is satisfactory for its operation.

This 2,000-HP. washer here under discussion is operated by an 80-HP., vertical, two-cylinder Westinghouse steam engine, the two being belted to a countershaft.

SCRUBBER.—The dry scrubber is really the final piece of apparatus connected with the gas plant proper. It is a large tank with a comparatively large diameter and small height, filled with a body of excelsior. The gas passes in at the top and out at the bottom or vice versa as may be most convenient, and, in passing through the excelsior, is freed from dust and moisture. The dry scrubber is provided with a water drain so that any moisture collecting at the bottom can be discharged. It is necessary to renew the excelsior only once every several months, the exact time varying with conditions, and there is not yet sufficient data to tabulate this. The cover of this washer is removable, with a flanged rim projecting into a water seal. This makes it possible to elevate the top at a moment's notice without the handling of bolts. Each dry scrubber is accompanied by a triplex chain block and trolley on I-beam track. This is extended also over the washer and used for installing, and is on hand for any occasion where it might be necessary to make repairs. This hoisting outfit is a regular part of the gas plant equipment.

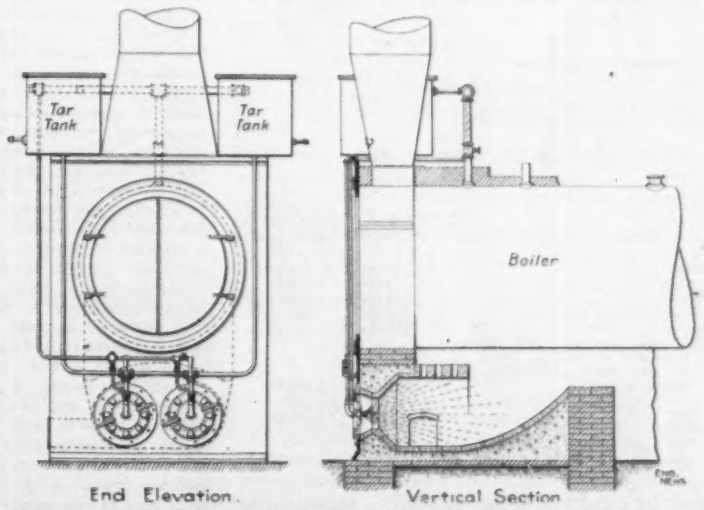


FIG. 8. AUXILIARY BOILER, WITH TAR FEED TANK AND BURNER.

TAR EQUIPMENT.—One of the unique features of the Industrial gas plant is the tar-collecting and burning apparatus. This is shown in the accompanying diagrams and photographs. The tar is discharged as has been described, the light tar passing over two steel aprons and the heavy tar discharging periodically from cocks at the bottom of the collecting tanks. Only a small amount of tar comes from the cooler, and frequently this is so mixed with dust as to be of little value, and the great bulk of the tar comes from the gas washer. As it leaves this tank it is practically a 50% emulsion with water, and is barely liquid enough to flow. It drips down into the dished head of the collecting tank, and periodically when this fills up the operator lowers the valve by pushing it down and allows the tar to pass down into the tank. When this collecting tank is full, or nearly so, the operator closes the valve and turns live steam pressure into the tank, which forces the tar down through the pipe going out at the bottom and up into a feed tank situated over the boiler. In connection with this 2,000-HP. plant there are two boilers and two tar feed tanks. On a 3,750-HP. installation we are now putting in, we are installing in addition to these tanks a 50-bbl. tar storage tank.

The entire equipment is steam heated by coils; these steam coils are placed within the tanks and through the pipes. This keeps the tar in a liquid condition, so it can be handled and burned in the same way fuel oil is burned. The only difference is the necessity for this continual heating at all points, even through the valves, and this necessitates somewhat bulky and expensive valves for the tar outfit. One of the diagrams shows the method of burning tar under a steam boiler. This equipment is operating in connection with 24-hour service, and is completely satisfactory; that is, it is satisfactory at one point where it has been finally perfected so it can be relied upon for continuous service without constant attention. In fact it requires scarcely more attention than does a fuel oil burner.

This equipment provides for the collection and burning of the tar, and makes it possible to use this by-product to develop steam to operate the steam engine driving the washer and steam for gas making. Complete statistics in regard to the amount of tar are not available, for the reason that this apparatus has only recently been developed, and has been in service at one plant only for the past three months, but results have already established the point that the tar will furnish at least one-half the steam necessary for the operation of the gas plant.

We are making designs now providing for changes in connection with this gas plant whereby the exhaust steam from the engine will be used at the producers for gas making and in the tar outfit. This feature in connection with more efficient steam engines or the adoption of high speed steam turbines will, it is hoped, make it possible to develop all the steam required from the tar by-product. This, of course, will depend upon the coal, as some coals contain very little tar, but at present it looks probable that most of the Pennsylvania, Indiana and Ohio bituminous coals will give sufficient tar to provide for the operation of the plant.

The third Industrial gas plant was installed for the Garford Co., Elyria, Ohio, and was started in May, 1908. Their entire gas equipment consists of a 750-HP. producer plant, 500 HP. in gas engines direct connected to generators, and a number of gas-using furnaces. Their entire equipment is piped for the use of both natural and producer gas so that either can be used, and their experience has shown that one gas can be turned on and the other turned off simultaneously without any interruption of work or without affecting operating conditions in any degree. This is true both of the engines and furnaces. The engines run full rated capacity under 115-lb. compression on producer gas, using the same compression as with natural gas. It was expected it would be necessary to raise the compression in order to get full capacity from producer gas but this did not prove to be the case, doubtless because the engines were somewhat under-rated. The engines, however, were thoroughly adjusted at the time they were operated on producer gas, and in fact are to-day developing more power on producer gas than they formerly did on natural gas. This is due to the better adjustment. The fact, however, is of interest as doubtless there are many plants throughout the country operating on natural gas which could be operated on producer gas without loss in capacity.

Very complete costs of power and of gas furnace purposes have been made up by the Garford Co., their en-

TABLE IV.—COST TO THE GARFORD CO., AT ELYRIA, OHIO, ON AN AVERAGE POWER LOAD OF 175-KW. PER HOUR, 3,000 HOURS PER YEAR, AMOUNTING TO A TOTAL OF 525,000 KW.-HRS. AT THE SWITCHBOARD, AND GAS USED IN FURNACES AVERAGING EQUIVALENT OF 4,000 FT. NATURAL GAS PER HOUR DURING 3,000 HOURS, OR A TOTAL OF 12,000,000 FT. PER YEAR.

COAL.

The plant ran successfully and for a long period on Ohio slack, but comparative tests determined it was cheaper to use Pittsburg run-of-mine on which they are now operating, the coal averaging 13,500 B. T. U. per pound, costing $1.10 at the mine with $1 freight and 10 cts. unloading charge, making the total cost of $2.20 per ton of 2,000 lbs. in the bins.

Coal burned in producer for gas for engines at 2.18 lbs. per KW.-hr. at switchboard, 175 KW. per hour =....	383 lbs.	
Coal burned in producer for furnaces requiring 85 lbs. to produce the equivalent of 1,000 ft., at 4,000 ft. per hour.	340 lbs.	
Coal burned in producer for gas burned under boiler	75 lbs.	
Coal burned under boiler.....	75 lbs.	
Total coal per hour.....	873 lbs.	
Total coal per day during working hours.	8,730 lbs.	
Stand-by losses at night.....	500 lbs.	
Total coal burned per day.....	9,230 lbs.	
Equals per year of 300 days, 1,385 tons, at $2.20		$3,046.00
Steam furnished by boiler, and the coal used by boiler is divided as follows:		
Steam for washer and engine, 36¼ HP..	1,260 lbs.	
Steam for producer.....	326 lbs.	
Steam for tar outfit.....	286 lbs.	
	1,872	
Supplied by 80 lbs. tar.....940 lbs.		
Supplied by 75 lbs. coal burned as gas .....492 lbs.		
Supplied by 75 lbs. coal burned on grate .....440 lbs.	1,872	

LABOR.

One head gas man, $0.25 per hour, 4,000 hours.....$1,000.00		
One helper, $0.18 per hour, 4,000 hours	600.00	
One extra man for ash, etc., $0.18 per hour, 1,500 hours.	270.00	
	$1,870.00	
One gas engine engineer at....$1,500.00		
One assistant at $0.225 per hour, 3,000 hours.....	675.00	
	2,175.00	
		4,045.00

WATER.

City water from Lake Erie: Engine water, 16 gals. per KW.....	8,400,000	
Washer water, 1,000 gals. per hour...	3,000,000	
Cooler, 1,750 gals. per hour.....	5,250,000	
Boiler, 250 gals. per hour.....	750,000	
At $0.06 per 1,000 gals.....17,400,000		1,044.00

MISCELLANEOUS SUPPLIES.

Oil	$320.00	
Waste and packing.....	60.00	
Sparking plugs	50.00	
		430.00

REPAIRS.

Estimated by engineer.....	520.00

OVERHEAD CHARGES.

15% on total cost estimated for power and fuel gas equipment of $51,620.....	7,743.00
Total annual cost for power and gas.....$16,828.00	

SUMMARY.

Items.	Cost of 525,000 KW. per year.	Cost of equivalent 12,000,000 ft. natural gas per year.
Coal	$1,635.00	$1,411.00
Labor	2,175.00	1,870.00
Water	504.00	540.00
Miscellaneous expenses	330.00	100.00
Repairs	320.00	200.00
Overhead charges, 15% on investment of which 37½% is for gas plant and 62½% for engine plant	4,843.00	2,900.00
	$9,807.00	$7,021.00

Cost per KW.-hr., $0.0187.
Cost for the equivalent of 1,000 ft. natural gas, $0.585.

gineering department having run a number of tests during which they took 15-minute readings on every possible line of data, including coal and water consumption, temperatures, pressures, switchboard readings, engine cards, gas analyses, etc. The final and official test was made during a continuous run of 125 hours made at a time when the plant was operating 24 hours per day. These tests have established accurately the constants governing the expense at which they operate. The plant usually runs ten hours per day 300 days per year, carrying an average power load of 175 KW. at the switchboard, and using on the average in their furnaces 4,000 ft. of natural gas per hour, or its equivalent. The figures in Table IV. indicate the costs for a period of one year under their normal average conditions.

Comparing the figures brought out by the three different installations under consideration, it may be noted that the cost of power at the switchboard is as follows for the three sets of figures given:

COST OF KW.-HR. AT SWITCHBOARD.

Average load 263 HP., or 175 KW., 10-hr. service, 300 days per year, coal at $2.20.....	$0.0187
Average load 1,320 HP., or 892 KW., 24-hr. service, 300 days per year, coal at $2.50.....	.008
Average load 20,000 HP., or 13,333 KW., 24-hr. service, 300 days per year, coal at $2.....	.004

COST OF THE EQUIVALENT OF 1,000 FT. NATURAL GAS.

Average use of 20,000 ft. per hr., coal at $2.00..	$0.2425
Average use of 4,000 ft. per hr., coal at $2.20....	0.585

In conclusion it may be said that the successful making of clean gas suitable for gas engines and small furnaces from bituminous coal and for continuous operation has been established beyond question; further that this type of apparatus will furnish perhaps the lowest cost of fuel to be obtained in a large portion of the country for large power plants and for shops requiring fuel gas in large quantities. The cost of the equipment, however, and of its operation, is such that under usual conditions this type of equipment is not a good investment for power plants below 250 HP., the simple anthracite suction producer presenting a better proposition; and the advantage of this type of apparatus for furnace operation would depend in every locality on the price at which natural gas and fuel oil can be secured and the quantity in which gas is required.

The figures given above show the cost under two different sets of conditions. A large plant in Pittsburg, with good gas coal at $1.25 per ton, to supply the equivalent of 250,000 to 500,000 ft. of natural gas per day, would show a cost of from $0.12 to $0.14 for the equivalent of 1,000 ft. of natural gas.

Cost of Concrete Construction as Applied to Buildings.*

By LEONARD C. WASON,† M. Am. Soc. C. E.

The writer is going to give in the course of this paper some actual job costs of various parts of building construction from his own experience. This kind of data is usually guarded with the greatest of care from every interested or curious eye outside the firm possessing it and often even from the trusted employee of the company. It is information usually known only to the manager and owners of a construction company and kept by them under lock and key.

It is not pure philanthropy on the writer's part to publish this cost data. If the selfish business motive is stated for so doing, perhaps more confidence may be placed in the figures given. Granolithic pavements have been so long in use and so many contractors have laid them that their cost is a matter of common knowledge not only to all cement users, but to the interested investing public. The result is that any contractor bidding a living profit above the actual cost of construction has a fair show of winning the job and the lowest bidder will usually make a profit. The same is true of building construction with brick and wood. Not so, however, is the case with concrete building construction. The art is too new to have methods or even designs standardized sufficiently to permit of cost data for present methods being very generally known. A great many builders are taking up this type of construction at the present time, some who are competent, many who are not. The novices under-estimate the cost and difficulties of doing good work, hence they bid unreasonably low, lose money and to some extent demoralize the true value of proper workmanship among architects, engineers and their clients. In the writer's opinion there is no class of construction where more painstaking skill and often technical knowledge is required than in reinforced concrete. When well done the resulting building is satisfactory to the owner beyond that obtained from any other material, and when poorly done it is the least desirable, even if not actually dangerous. Concrete is either good or bad. There is no half way state, and the difference in cost of materials to the builder between perfect results and a dangerous structure is only 5%. Therefore there is likely to be serious injury done to a rapidly growing industry by novices who either on account of ignorance, though coupled with honest, well meaning intent, or through skinning a job on which he is sure to lose money. Moreover, the older firms in the field have little to fear from the beginner because so much depends on personal ability as well as experience. With growing competition improvements are constantly being developed. The standard of cost is not yet fixed but is being reduced steadily. The desire of reducing the present wild bidding and having only intelligent competition as well as saving some poor builder a loss he cannot afford is the real inspiration of this paper. The author has undertaken it with the understanding that other competent writers would discuss it so that a greater good will result.

In order to have an intelligent understanding of the meaning of the figures hereinafter given, the method of collecting data will first be described. When making up an estimate of the cost of a building; in scheduling the plans, it is found convenient to take off the various items of excavation and backfilling, the cubic feet of concrete in footings, foundation and wall, the square feet of forms for walls of foundations and above grade, the lineal feet of belt courses, moldings, cornices, etc., and also the number of special features of exterior treatment. Similarly the superficial area of column and floor forms are measured by themselves. Concrete of each different mixture is scaled off in cubic feet and totaled separately. Steel of each kind is taken off in pounds. Granolithic finished surfaces in square feet and so on, in detail every item is measured. As the work progresses it is desired to know weekly how the actual experience compares with the estimate and at completion to compile correctly the costs of each item to compare with estimate and to aid in obtaining the true cost of future structures of a similar kind. The method of accounting was developed to fit the estimate.

In the year 1898 daily time reports were designed having a number of columns for ease in sub-dividing the time of the workmen. At the head of each column the timekeeper puts index numbers or letters to show the kind of work being done and below the actual time the men worked. On blank spaces at extreme right of the report the timekeeper inserts in writing the amount of each kind of work done and the amounts of the principal materials used. The experience of eight years has required no change whatever in the principles first adopted. The only change in the forms has been to increase the number of vertical columns so that a larger number of sub-divisions can be used without troubling the timekeeper to rewrite the names on another sheet. At the present time ten vertical columns are used for recording time with the names of the workmen at the extreme left, two columns being left at the right for the rate per hour and the total amount. At the beginning of a job written instructions are given as to how the work is to be subdivided into items in the reports. A standard method of classification has been adopted as follows:

The principal sub-divisions are given a capital letter. Thus everything whatsoever relating to concrete masonry is given the index letter M, excavating of all kinds, including work incidental thereto, the letter D, all work connected with plant the letter P, and so on, there being only six or seven sub-divisions to indicate every building operation. To indicate the kind of work vowels are used. Thus the vowels beginning with "a" all relate to form work, as: "a," centering complete; when done by separate operations, "aa" is making, "ae" is setting, "ai" is straightening up or bracing, "ao" removing after being used, and "au" cleaning up and handling ready to be used again. All labor connected with mixing and placing concrete or with handling materials for same goes under the head of "e," all work in connection with plant, receiving, erecting, taking down, shipping and repairing is indicated by the vowel "i." Thus "I" means receiving and setting up plant ready to work, "ia" taking down, removing and shipping, and "ie" repairing. The consonants are used to indicate different parts of a structure in which certain work is done. Under classification "M," "b" stands for footings, "e" columns, "d" foundations, "f" floors, "g" stairs, etc. Under classification "P," "f" stands for boiler, "g" for horizontal engine, "h" for vertical hoisting engine, "l" for elevator, "m" for mixer, etc. Thus our timekeeper places at the head of a column when he is reporting concrete floors, for the placing of forms "Maaf," for concrete "Meaf." If a mixer is being set up ready to work the report would read "Pim" and later if it was repaired it would be reported under "Piem," etc.

This is not so complicated to use as it may appear to read, and experience has proved that every man who knows enough to keep time can use the system with a few days' experience. The principle is to make the least amount of clerical work to the timekeeper on the job, as they have plenty of other work to do. In addition to sub-division of time as above set forth, it is the duty of the timekeeper to report the number of barrels of cement mixed in a day, which is usually done by the man in charge of the mixer counting the empty bags, and in addition the actual volume of concrete measured in place. From this, knowing the proportions, it is a very simple matter to obtain the amount of sand and stone used and also to see if the right amount of cement is being used. Carpenter work on forms is reported by the number of square feet of surface in contact with the concrete erected. Thus walls are measured two sides without deducting doors and windows, as it is usual to let the form work run straight across these unless it is impossible on account of moldings, in which case the framing of the opening will cost as much as the form work omitted. Beam floors are measured around the perimeter of the beam and the flat surface of the panel and around the perimeter of girders. No deduction is made for the loss of area by the intersection of beams and girders, and small openings in the floor are not deducted. Anything as large as an elevator or stairway is usually deducted. Form work for columns is measured for entire area of surface contact between wood and cement, all four sides. These reports are made out on the job daily and sent to

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TABLE I.—SHOWING COST OF FORMS AND CONCRETE ON VARIOUS MEMBERS IN REINFORCED-CONCRETE STRUCTURES.

PLAIN CONCRETE COLUMNS

Location.	Forms per sq. ft. Carpenter labor.	Lumber.	Nails & wire.	Total.	Concrete per cu. ft. Concrete labor.	Gen. labor.	Cement.	Aggregate.	Team & Misc.	Plant.	Total.
Office building, Portland, Me.	$0.133	$0.039	$0.001	$0.173	$0.064	$0.004	$0.087	$0.084	$0.012	$0.022	$0.273
Coal pocket, Lawrence, Miss.	.057	.024	.001	.082	.166	.003	.073	.041	.008	.016	.307
Mill, Smithbridge, Mass.	.097	.082	.002	.181	.073	.056	.107	.035	.027	.030	.328
Mill, Attleboro, Mass.	.093	.022	.001	.116	.110	.014	.062	.038	.013	.034	.271
Mill, Smithbridge, Mass.	.080	.056	.001	.137	.108	.048	.100	.037	.013	.034	.340
Coal pocket, Hartford, Ct.	.098	.047	.002	.147	.089	.043	.069	.055	.017	.013	.286
Garage, Brookline, Mass.	.071	.051	.002	.124	.070	.028	.072	.058	.041	.020	.289
Warehouse, Portland, Me.	.118	.016	.001	.135	.087	.027	.087	.070	.039	.025	.335
Textile mill, Lawrence, Miss.	.061	.013	.001	.075	.095	.019	.109	.027	.018	.015	.283
Highest	.133	.082	.002	.181	.166	.056	.109	.084	.041	.034	.340
Lowest	.057	.013	.001	.075	.064	.003	.062	.027	.008	.013	.271
Average of 9.	.082	.036	.001	.130	.096	.027	.085	.049	.021	.023	.301
REINFORCED-CONCRETE BEAM FLOORS.											
Highest	.165	.107	.004	.275	.186	.035	.194	.101	.052	.035	.470
Lowest	.037	.027	.001	.067	.047	.004	.071	.037	.007	.010	.202
Average of 18.	.070	.045	.002	.116	.111	.020	.106	.063	.025	.024	.354
FLAT SLAB FLOORS.											
Highest	.078	.039	.003	.118	.146	.017	.109	.084	.026	.039	.374
Lowest	.067	.037	.001	.106	.043	.004	.087	.053	.012	.010	.252
Average of 3.	.071	.038	.002	.111	.097	.009	.096	.070	.019	.024	.315
REINFORCED-CONCRETE SLABS BETWEEN STEEL BEAMS.											
Highest	.110	.071	.003	.184	.144	.048	.208	.080	.064	.046	.428
Lowest	.028	.012	.001	.049	.073	.005	.076	.026	.004	.010	.272
Average of 13.	.061	.032	.002	.095	.102	.019	.128	.068	.024	.017	.359
BUILDING WALLS ABOVE GRADE.											
Highest	.136	.073	.005	.176	.146	.052	.105	.187	.077	.055	.446
Lowest	.046	.016	.001	.079	.042	.004	.034	.043	.007	.005	.174
Average of 17.	.085	.036	.002	.128	.090	.016	.073	.076	.025	.019	.301
FOUNDATION WALLS.											
Highest	.134	.048	.004	.193	.213	.037	.203	.116	.057	.040	.599
Lowest	.032	.009	.001	.056	.040	.002	.038	.027	.003	.010	.148
Average of 14.	.068	.033	.002	.103	.076	.015	.080	.062	.019	.017	.269
FOOTINGS AND MASS FOUNDATIONS.											
Highest	.119	.077	.003	.198	.081	.020	.098	.099	.013	.049	.275
Lowest	.016	.006	.001	.018	.025	.001	.047	.043	.003	.010	.181
Average of 10.	.057	.034	.002	.093	.045	.007	.071	.077	.007	.021	.229

the office. The bookkeeper works these reports up into units of measurement, as cost of labor per cubic foot of concrete and number of cubic feet of concrete per barrel of cement, number of square feet of form work erected, etc., and from this it is easy to obtain the unit cost hereinafter given. The bookkeeper can take the reports of four or five jobs, employing in the aggregate five or six hundred men, and in a single day work up the complete report for a week's time, thus it will be seen that there is really little extra labor involved in the subdividing of reports into a useful form over merely reporting the time so that the payroll can be accurately made.

Materials received on the job are reported on cards especially printed for the purpose, listing the principal materials which are reported, in order to save work of the timekeeper in reporting materials accurately. When a job is entirely completed and the ledger account is closed, a master card (Table II.) is worked out giving the complete history of the cost. On one side of the card are written the items which went into the original estimate, such as excavation, back-filling, footings, foundations, columns, floors, walls, stairs, etc., etc. In parallel columns is placed the actual amount of the estimate with the actual experience, reduced to cost units such as cubic feet, square feet of form work, etc., and the percentage of profit or loss between the estimate and actual results. On the reverse side of the card the principal items are worked out more in detail. Thus form work is reduced to cost of labor, lumber and nails, wire or other sundries used in the forms per square foot of surface. Concrete is itemized into the superintendent's general labor, labor of mixing and placing, cost of cement, sand, stone miscellaneous expenses such as teaming, plant and other general items, reduced to cubic foot measurement, which makes the total cost of the concrete in place in each division of the building itemized for ready reference when making up future estimates on work of a similar character.

It is well known that the cost of materials and labor in different parts of the country vary somewhat. Having the unit items all subdivided as above stated into their elementary parts, it is an easy matter after determining the cost of materials in any locality to make the exact corrections to the results obtained on a previous job. Similarly, when a difference in the rate per hour for wages is known, if the same efficiency is obtained from the men it is very easy to make a correction, or if the efficiency varies, judgment must be applied to determine the correct rate to use. It has been the writer's experience that although the rate of wages and cost of materials vary somewhat in different parts of the country, the variations frequently offset one another so nearly that the sum total of the unit cost obtained in one place may be used in another, very seldom needing correction. For instance, within one month, after careful investigation, a bid was made upon a structure at San Juan, Porto Rico, using the same unit costs as for a building in Boston. In the report that is given, the costs relate to strictly first-class material and workmanship in every case, as it has been the endeavor of the writer to establish and maintain one standard for all work. In general the standard mixture for all floors has been either 1:3:6 or 1:2:4 if the floor is subjected to extremely heavy loads and service. Walls are mixed 1:3:6 and columns usually 1:2:4 in some cases where they are very heavily loaded a richer mixture is used. As these mixtures are common to nearly all construction the costs here given may be applied with little danger of error from neglecting the mixture on any work. Of course it can readily be understood that in the large number of jobs which have entered into the averages given, there being as many as 18 in the case of beam floors, different methods of conducting the work have been used and many different foremen. Therefore, while the general average is doubtless safe for any work of an average character, some latitude may be allowed the judgment in determining whether any specific case is likely to be difficult, easy or average. The writer has found quite a difference, for instance, in cost of identical work handled by different foremen, due to the personal equation of their painstaking, supervision and ability.

In the following tables* only typical jobs are given, whose results are correctly known. The results of a number of jobs have been spoiled by a change of timekeeper during the progress of the work, the new men missing for a day or two the proper classification or some other such small matter. It appears to the writer, moreover, that the results from a few typical jobs would be of more interest than a mass of figures from all kinds, some of which would be of no value. Enough are given for a fair average, except in the case of long span first flat slab, which is, by comparison, a recent type of construction. The figure for the highest, lowest and average totals in the fourth and last columns are taken from the vertical column in which they stand and have no relation to the other figures in their horizontal line.

By reference to the general averages on form work in the foregoing tables of forms per square foot of surface contact, namely, columns $0.13, floors with reinforced concrete beams $0.116, flat floors without beams $0.111, short span slabs between steel beams including the fireproofing on the sides of the beams $0.095, walls exposed to view above ground $0.128, foundation walls $0.103, mass foundations $0.093, the writer believes all higher in price than usually believed to be a fair cost by the majority of builders. It is upon the success of handling forms that good results financially depend. In regard to concrete, labor is the variable item which must be carefully considered. Any one of intelligence can make a careful estimate of the materials to be used but note the average prices of labor per cubic foot of concrete, namely, for columns $0.123, beam floors $0.131, flat floors $0.106, floors between steel beams $0.121, walls $0.106, foundations $0.091 and mass work in connection with buildings $0.052; not until the last item is reached is a price obtained in experience which, according to the observation of the writer, the majority expect to obtain in building work in general. Many men who have had wide experience in handling large quantities of concrete in mass have at times attempted a lighter type of construction and been greatly surprised at the large expense connected therewith. It has come to the writer's notice a number of times that men with this experience have added 50% to 100% to the cost of mass work and felt that they were amply covered for light structural work.

Table II. is an exact copy of a "master card" which gives the complete financial history of the job when it is finally completed. The first column, which is blank, is occasionally used for an estimate of the first cost, the proposal including the profit as well as the estimated actual cost. It will be seen that on some items, a loss was incurred, as well as a profit on others, showing that it is difficult, even on work which a company is fairly experienced on, to reach the right price on everything, and also that when slight changes are made by the owner or architect they often entail heavy loss even though the changes appear to be extremely trivial. Take the case of the external walls. The owners furnished the window frames and sash, which were all of metal. The original design was for a frame with two sash, which could easily be put into a 6-in. wall. They later decided, for greater fire protection, to use four sash. This required an 8-in. wall instead of 6-in.; and the form work on the inside had to be built inward and then the space under the windows paneled to save material. To save making a very narrow panel at the side of the window, which would cost more than the concrete saved, the space was filled up solid so that the columns appear to be wider than they were actually figured. This slight change, which did not appear great at the time, when the job was entirely complete showed that the concrete on the walls showed an actual loss instead of profit and that the form work cost more than twice what was originally estimated that it should cost.

Regarding the tooling of wall surfaces, we originally

*[The author in his original paper gives a tabulated, itemized statement of the costs of the various members of reinforced-concrete structures erected by his company. For each of these members figures are given for from six to twelve jobs, and also the highest, lowest and average costs among these various jobs. In the tables which we publish, we have omitted the detailed statements on account of lack of space, and have printed only the high, low and average figures. Under the heading "Concrete Columns" the entire table is given, showing the scheme of the tables in the paper as read.—Ed. Eng. News.]

TABLE II.—TYPICAL "MASTER CARD."

Job No. 747. Date, May 24th, 1906. Mill, Tappan Bros., Attleboro, Mass.

	Proposal	Actual cost.	Per cu. ft.	Profit.	Loss.	%
Total	$35,164.55	$31,330.48	....	$3,834.07	....	11
Excavate	790.00	823.18	$0.021	.....	$33.18	..
Footings and Fn.	1,738.00	1,033.57	.137	704.43	....	..
			Per sq. ft.			
Exterior walls	1,955.00	2,162.02	.190	.....	207.02	..
Wall and Fn. centers	1,520.00	3,630.08	.125	.....	2,110.08	..
Floors 6½ ins. thick	8,883.00	6,544.16	.339	2,338.84	....	..
Roof 5¼ ins. thick	2,889.00	1,713.51	.237	1,155.49	....	..
			Per lin. ft.			
Columns, 20 ins. × 20 ins.	832.00	676.65	1.470	155.35	....	..
Stairs	883.00	910.35	.912	.....	27.35	..
			Per sq. ft.			
Tool surface	469.00	636 53	.056	.....	167.53	..
Ornaments and cornice	348.00	164.33	....	183.67	....	..
Ventilators on roof	44.00	35.64	....	8.36	....	..
			Each			
Set windows and door frames	852.00	729.99	2.19	122.01	....	..
			Per sq. ft.			
Interior partitions	1,770.25	1,656.35	.189	113.90	....	..
Bolts and iron works	253.00	257.06	....	.....	4.06	..
Stair railing and grill	387.00	654.00	....	.....	267.00	..
			Per M.			
Screeds and setting	1,086.00	835.12	52.17	250.88	....	..
2-in. Spr. plank and laying	2,839.00	1,431.60	33.30	1,407.37	....	..
⅞-in. maple	1,738.00	1,788.88	89.44	.....	50.88	..
Motor shaft	379.50	533.19	98.89	.....	153.69	..
Motor shaft found	98.00	70.07	....	27.93	....	..
Roofing and conductors	1,255.00	1,026.06	....	228.94	....	..
			Per sq. ft.			
Paving	1,009.00	647.54	.094	361.46	....	..
Retaining wall centers, per sq. ft.	.....	.....	.211	.....	....	..
Retaining wall, concrete per cu. ft.	429.00	316.90	.175	112.10	....	..
Painting	400.00	375.00	....	25.00	....	..
Steel footings and walls	300.00	218.91	....	81.00	....	..
Plant, frt., etc.	1,860.00	2,271.73	....	.....	411.73	..
Bond	100.00	120.00	....	.....	20.00	..
Extras	77.80	67.97	....	9.83	....	..

planned to do this when the cement was less than ten days old, but on account of the various changes forms had to be left on a considerably longer time and it was inconvenient to tool the surface until the cement was so thoroughly set that the cost of dressing was considerably greater than was first anticipated. Again, by reference to the ⅞-in. maple floor which was placed upon the concrete construction, a cost of $89.44 per M. bd. ft. will be observed, and repairing floor cost $248.50, or $12.42 per thousand (not shown on front of card). This was due to the fact that the owners did not deliver or set the window sash at the time agreed and therefore the maple floors lay exposed to the weather in the building for several weeks, swelled and, after laying, shrunk, leaving large cracks which the owners insisted on being filled before they would accept the work. These indicate how matters which appear trivial at the time may cause serious loss if overlooked.

As seen by the large list of items entering into the estimate as given by this master card, there are various items of cost entering into the construction besides those which are enumerated. Nevertheless the matter of the forms, steel and concrete covers by far the largest proportion of the cost of a reinforced-concrete structure and the minor items are those which are peculiar to each individual case and which any person can easily estimate for himself.

What Sometimes Happens to Wooden Piles During Driving.

By JULIAN GRIGGS,* M. Am. Soc. C. E.

As a good illustration of the occasional behavior of wooden piles beneath the surface of the ground into which they are driven, I herewith show four photographs showing a few out of 34 piles used in four bents to support two tracks of the Norfolk & Western Railway at the subway under construction in the season of 1908 crossing over the Groveport pike near Columbus, O. The track was raised about 8 ft. and the piles were then driven through the new embankment and into the natural soil of dry compact boulder clay, which was subsequently excavated for the highway to a depth of 17 ft. below the base of rail, thus exposing to view a portion of the piles beneath the natural surface of the ground.

The driving was done with the ordinary railway track driver having leads 40 ft. in length and a drop hammer of 3,800 lbs. weight. The piles were a good quality of well-seasoned white or chestnut oak, about 12 to 16 ins. in diameter at the butts, and 8 to 10 ins. in diameter at their tips, 26 ft. long and securely shod with cast-iron points.

The piles shown in Figs. 1 and 2 telescoped, the upper portion having been driven over the lower and being split thereby.

Fig. 3 shows a buckling pile, and Fig. 4 shows a similar failure, the pile slivering and bending in two directions, almost 180° at each bend, to form a letter S, well illustrating the excellent quality of the timber under a treatment which would have been a severe cold bending test for the best quality of steel.

Several of the piles were so badly broken that after excavation they afforded no bearing resistance whatever, and the weight of track in such case was supported by bolted sash pieces which transferred the load to adjacent piles, or by blocking cribbed up from the bottom of the excavation. Out of 34 piles driven, 13, or 38%, failed more or less completely. One pile was turned about 18° from the vertical by hitting a boulder.

In estimating the effective bearing power, or the liability of piles undermining by erosion in exposed situations, it is sometimes assumed that the points penetrate to the depth which their measured length before driving would indicate. The illustrations herewith afford an object lesson to the inexperienced, and suggest caution in estimating pile penetration, and the unwisdom of continued pounding with the hammer after a pile has been driven to a practical refusal.

For the weight of hammer, length of lead, etc., I am indebted to Mr. Chas. F. Losh, Assistant Engineer, Norfolk & Western Railway Co., under whose general supervision this work was done.

*Chief Engineer, The Scioto Valley Traction Co., Columbus, Ohio.

Fig. 3. Pile Buckled in Driving.

FIGS. 1 AND 2. PILES TELESCOPED IN DRIVING.

RAILWAY TIE TESTS are being carried on by the U. S. Bureau of Forestry in conjunction with the Northern Pacific R. R., and the scope of the experiments and some of the preliminary results have been made public. The government bureau entered into an agreement with the railway to investigate the tie timber accessible to its line, in order to determine the best and most economical methods of handling these timbers when manufactured into ties. The timbers used in these experiments were Douglas fir, western hemlock, western tamarack and giant arborvitae. There were three separate investigations; first, to determine the green weight and rate of seasoning of timbers cut in different months; second, to determine the absorptive power of seasoned timbers cut in different months; third, to determine the comparative durability of green, seasoned and treated timbers when laid in a test trench under similar conditions and with various tie-plates and rail-fastenings. The results from the last of these three sets are not yet available, but in U. S. Forest Circular, No. 146, by Mr. H. B. Eastman, the following conclusions are made in regard to the first two sets of tests, or seasoning and treating:

(1) There is practically no difference in the rate of seasoning of 7 by 2 and 8 by 1 forms of piles. The rate of seasoning, as affected by the position of the pile, depends largely upon local conditions.

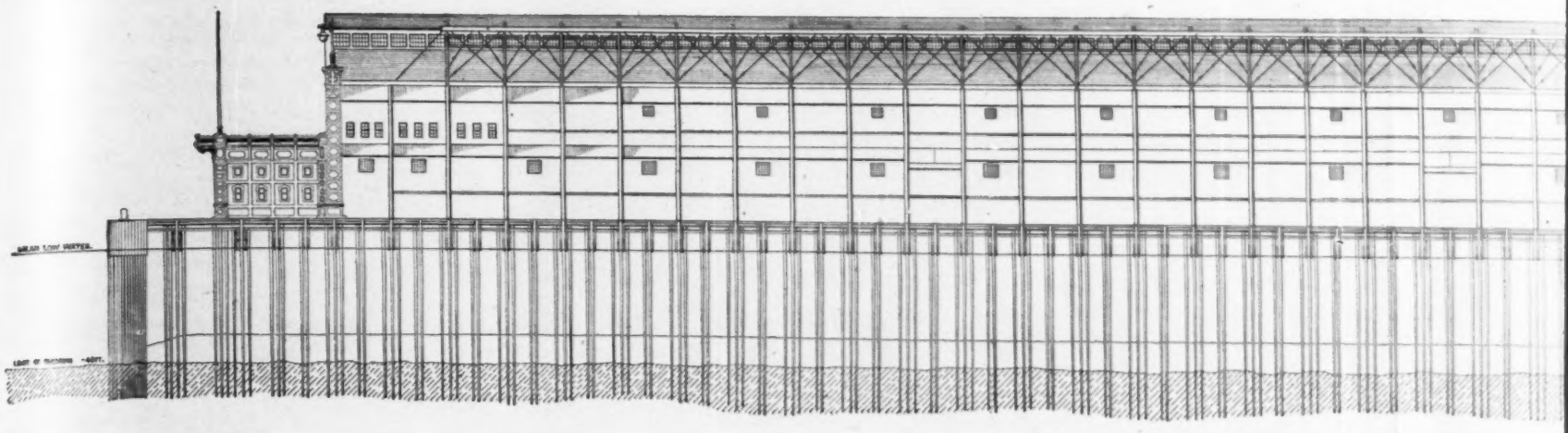
(2) Hewed ties, which are peeled when cut, season much more rapidly during the first four months than unpeeled ties. At the end of a year's seasoning, however, the weights of both peeled and unpeeled [illegible] are approximately uniform.

(3) The oven-dry weight of Douglas fir is 28.[illegible] per cu. ft. The green weight varied from 41.7 lbs. [illegible] February to 37 lbs. in July. The minimum air-[illegible]soned weight reached was 31.9 lbs. per cu. ft.

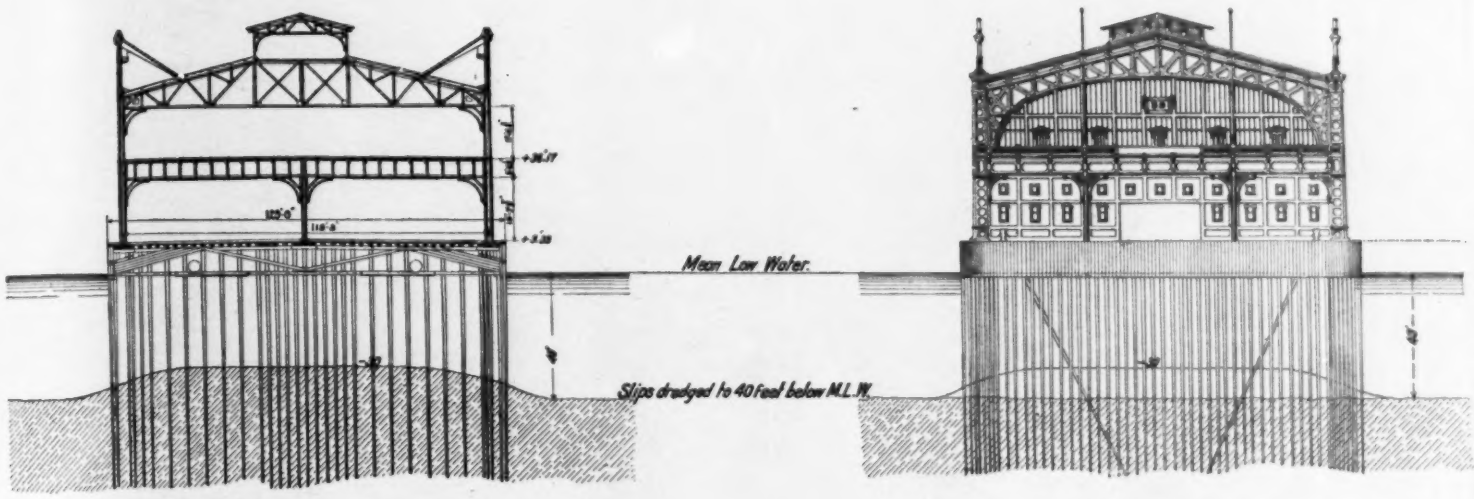
(4) Two distinct forms of checks occur on [illegible]uglas fir—radial and honeycomb. Timbers cut in Ju[illegible] July and August are particularly subject to radial c[illegible]king. Honeycomb checks both follow the curves of the [illegible]nual rings and are at right angles to them; they seldom extend more than 2 ins. on the radius and form small, roughly rectangular figures when seen in cross section. Radial checks are by far the most destructive, and the practice of cutting tie and bridge timbers from Douglas fir and western hemlock during June, July, August and September should be discontinued. Furthermore, at all seasons dimension material over 6 by 6 inches should be partially seasoned before being shipped east of the Cascade Mountains.

(5) Hewed ties peeled directly before treatment absorb more preservative than those peeled when cut, provided they have seasoned for an equal length of time.

Fig. 4. Pile Buckled, Slivered and Bent in Two Directions.

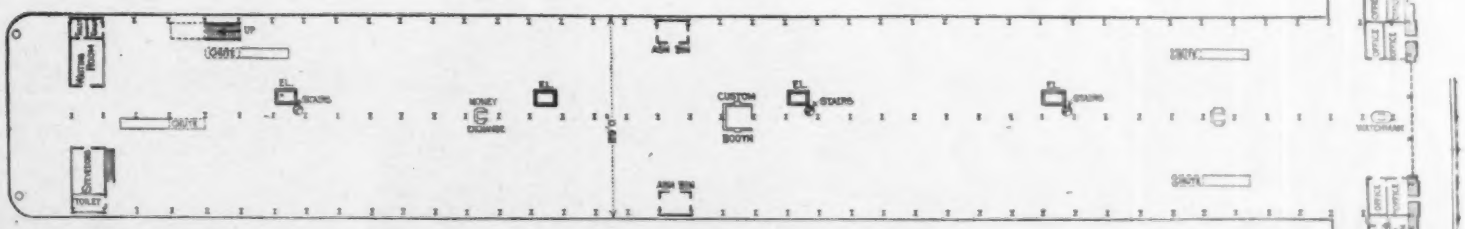


SIDE ELEVATION OF PIER-SHED AND CROSS-SECTION O

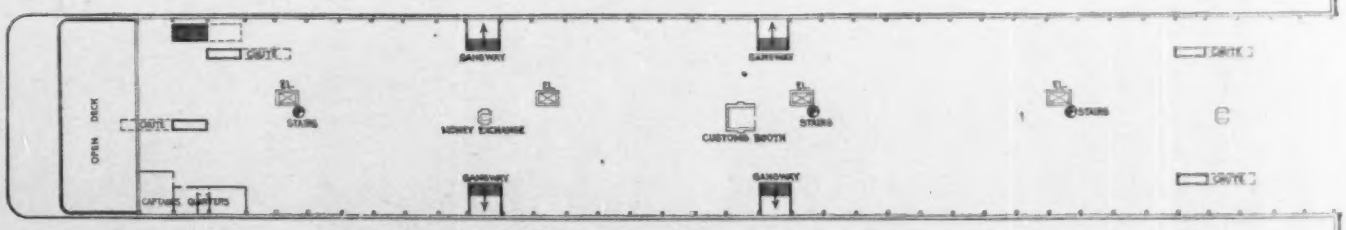


CROSS-SECTION OF PIER-SHED.

RIVER END ELEVATION.



PLAN OF LOWER FLOOR.



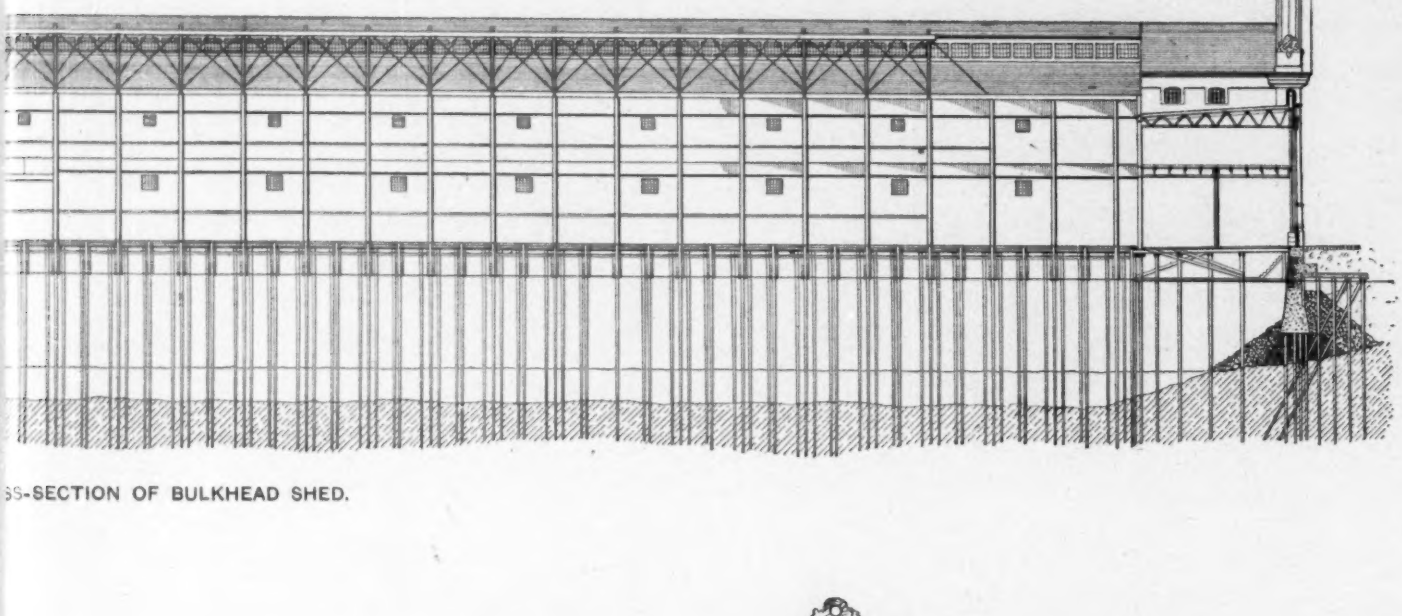
PLAN OF UPPER FLOOR.

NEW PIER-SHEDS FOR TRANSATLANTIC STEAMSHIPS, CHE

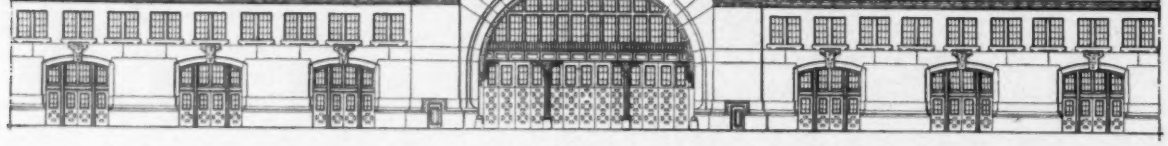
DEPARTMENT OF DOCKS AND

A. N. SPOONER,
Commissioner of Docks.

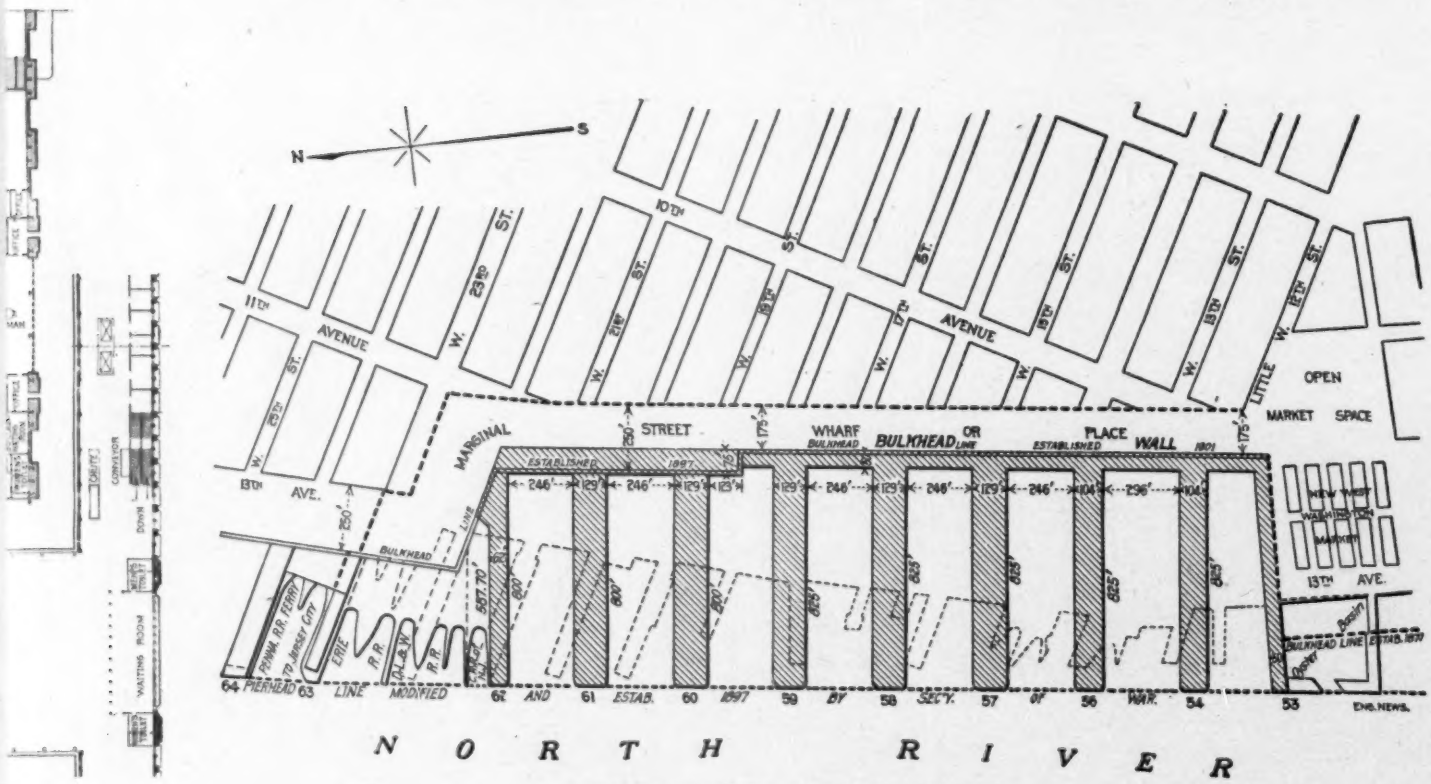
C. W. STANIFORD,
Chief Engineer.



SS-SECTION OF BULKHEAD SHED.



ELEVATION OF STREET FRONT OF ONE PIER-SHED AND PORTIONS OF ADJOINING BULKHEAD SHEDS.



GENERAL PLAN OF CHELSEA IMPROVEMENT.

, CHELSEA IMPROVEMENT, NEW YORK CITY.

AND FERRIES.

RD,
r.

S. W. HOAG, Jr.,
Deputy Chief Engineer.

ENGINEERING NEWS

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A vast deal has been said and written concerning the lack of facilities for freight handling in American seaports. Many a time has the contrast been drawn between the port facilities of European coast cities and those of New York or Boston or Philadelphia. Particular stress has been laid on the extent to which European ports are provided with wharf cranes and shears for handling heavy weights, and the rarity of such machinery here.

It is of particular interest, therefore, to find a published statement by a large shipper that New York harbor in particular is actually better equipped than foreign seaports for placing heavy machinery on board vessels. This statement occurs in a paper by Mr. E. F. Colyer, of the General Electric Co., on "Foreign Transportation Problems," in the "General Electric Review" for January. We quote from it as follows:

> For the handling of very heavy machinery, the harbor of New York is very well equipped. In foreign ports the cranage facilities are usually limited to fixed shears, or to cranes forming part of the dock equipment. New York, however, is served by a very complete system of floating derricks, those operated by the railroads having a capacity up to 20 tons. Besides these, there are a large number operated by independent concerns, having capacities up to 50 or 100 tons, while the Merritt & Chapman Derrick & Wrecking Co. have one boat capable of handling pieces up to 250 tons in weight. Freight steamers do not customarily handle pieces in excess of five tons with their own tackle, although sometimes, when lines run to ports where the cranage facilities are limited or excessively expensive, the boats are equipped to handle pieces up to 20 tons in weight. All deliveries of heavy apparatus are made to steamers by lighters, the smaller floating derricks being also used for this purpose, while derricks of larger capacity are customarily used merely for lifting from car to lighter and from lighter to steamer.
>
> In foreign ports where only fixed shears are available for the handling of heavy lifts, the steamer itself must be moved under the shears, an operation attended with considerable trouble, and sometimes delay. If the customary berth of the vessel be in a dock not so equipped, it is frequently necessary to wait for high tide to permit transfer from one dock to another, the great rise and fall of the tides requiring that the various docks be built on the same principle as canal locks, and only to be entered at flood tide. In the shipment of a large generating plant for the Tuileries, the shears were needed for the discharge of the turbines; and as a shipload of locomotives was despatched from Philadelphia to Bordeaux at about the same time that the two turbines left New York, special arrangements were necessary to ensure that the steamer carrying the turbines should arrive first, as heavy demurrage charges would have accrued had it been necessary to await the discharge of the locomotives.

If the above statements are correct—and they appear to be based on actual experience—it is doubtful whether American engineers will do well to copy European practice in the equipment of wharves and docks. It looks entirely reasonable that the floating derrick which can go anywhere about the harbor where it is needed should have great advantages over the fixed shears, to which both the machine to be lifted and to the steamship to be loaded must be brought. It is certainly far easier to move a lighter than to move an ocean steamship.

We are accustomed to receiving at the office of Engineering News all sorts of requests from all sorts of out-of-the-way corners of the earth; but one received during the past week is unusual enough to be worth a note of mention here. A letter from an occasional correspondent in Abyssinia sends us an order for a steam pump to raise water to the palace of King Menelek from a hot spring 1,200 meters distant and 114 meters below. We venture the following quotations from the letter:

> The hotness spring water is 78° centigrade, and the Emperor want a sufficent hot water to bring a bath.
> The King will paid just when the water come hot to him palace.

It is a pleasure to be able to contribute in some small degree toward the lightening of "darkest Africa."

In our issue of Jan. 30, 1908, we published a word of caution to engineers who are offered positions in a new enterprise on condition that they will invest money in it. Several cases have been brought to our notice where new schemes of doubtful or more than doubtful standing were securing subscriptions to stock from prospective employees. Our warning came too late to save one of our subscribers from an unfortunate experience, an outline of which is given in a mass of correspondence which he has forwarded to us.

Just prior to the publication of our note of warning above referred to, this engineer subscribed for 25 shares of the capital stock of a trolley enterprise, at $15 per share, under an agreement that he was to have an annual salary of $1,800 and a permanent position on the engineering staff in the construction and operation of the road. The promoter of the enterprise gave assurances that financial arrangements had been made with a bond house in New York City, that a British syndicate was underwriting the bonds, and that active engineering work would at once begin. The engineer who "took the bait" was a comparatively young man of limited experience, and the high salary offered, together with the fact that the location was especially advantageous for him, overcame his instincts of conservatism.

The correspondence which follows makes interesting reading. Almost as soon as the money was paid over, the engineer began to grow suspicious of the enterprise and began to look up the promoter's record. The latter advertised himself on his letterhead as a member of the Institution of Mechanical Engineers and of the Institute of Electrical Engineers of Great Britain. A letter to New York, to the secretary of the American Society of Civil Engineers, brought the information that the promoter's name was not to be found in the published membership lists of these societies. The promoter also claimed to be contracting with the Allis-Chalmers Co. for machinery, and a letter to them brought the reply that they had no record of any contracts with the concern. A letter to the bond house in New York which the promoter had claimed was financing the enterprise, brought the information that they were ready to do the financing when the company had complied with certain unstated conditions (which, it may be surmised, were the securing of local subsidies). Meanwhile, the promoter wrote frequently to the engineer, making various excuses for the delay in beginning work. One comical excuse was that he was negotiating with Sir Douglas Fox, of Great Britain, to finance the work, and that Sir Douglas himself, with associates, was to come to America and go over the proposed line. The promoter even wrote from New York of meeting the son of Sir Douglas Fox in New York City, and of Sir Douglas himself being ill from heat prostration in Montreal. The engineer checked up these statements and found, by writing to steamship companies, that Sir Douglas Fox had not arrived at Montreal, and a letter to Sir Douglas Fox himself brought the information that he or his firm had nothing to do with the enterprise, and that Sir Douglas had not been in America for several years.

Convinced by this time that the whole scheme was a fraud, the engineer placed the matter in the hands of an attorney, and by threat of criminal prosecution for obtaining money under false pretenses he was fortunate enough to compel the promoter to disgorge. About a month ago he received back the money he had originally invested.

We publish the story as a further warning to any of our readers against deception by promoters of this class.

Our library of chemical literature has just been enriched by a prospectus which states that smoke "is today mastered by a device sold to the International Smoke Condenser Co. for $5,000,000."

The process which the company controls (and in which the reader is invited to become part owner to the tune of a dollar a share) is lucidly described as follows:

> The method used to condense smoke by the company is this: We put a pipe on your furnace and pull the smoke into a series of galleries made of concrete placed under the ground; the smoke remains in these galleries for a short time, when it is drawn off into a series of metal bottles. These bottles are arranged upon shafts having connection with an eccentric which gives them a 12-in. blow. The object of this blow is to separate the chemical ether from the ammoniacal gas, thereby liberating the carbon and sodiums, depositing and recovering them again in the form of coal tar.

The Demand for Electric Operation of Steam Railway Terminals in Cities.

As we have several times predicted, the successful operation by electricity of the New York Central and New York, New Haven & Hartford terminal lines at New York City is leading to a demand in numerous other cities that a similar change be made from steam to electricity. This demand receives further force, of course, from the extensive use of electricity by the Pennsylvania R. R. on its Long Island terminal lines, soon to be supplemented by the operation of its new passenger terminal on Manhattan Island; and also from other notable cases of electric operation of steam railways, such as the Pennsylvania line to Atlantic City, the Grand Trunk line under the St. Clair River at Port Huron, and the operation of the Cascade Tunnel in Washington by electric locomotives.

We gave in our issue of Dec. 24 the recent report of a special commission at Chicago on the introduction of electric traction on the Illinois Central R. R. terminal lines. Besides the public agitation going on there to compel the use of electricity, more or less is heard concerning it at Washington, Philadelphia and Baltimore. Similar agitation at St. Louis, where the smoke nuisance is particularly bad, may almost certainly be expected. At Boston the State Board of Railroad Commissioners went on record a year ago as strongly favoring a resort to electricity for motive power. In its report a year ago the Board said:

> The source to which the general public may rightfully look for final relief from the smoke nuisance is the use of electricity as a motive power and the abandonment of steam locomotives.

The Board also recommended a year ago that the railroad companies terminating in Boston should at once undertake studies as to the cost

and the whole question of electric installation, and, on Oct. 2 last, called upon the various companies to report on the progress they had made.

In the report of the Commission just presented to the Legislature, are given the replies of the several companies to this request, and they make very interesting reading. The first reply is that of the New York, New Haven & Hartford R. R. Co., signed by Mr. C. S. Mellen, the President, and we quote from his letter as follows:

We believe we are warranted in stating that our electrical installation is a success from the standpoint of handling the business in question efficiently, and with reasonable satisfaction, and we believe we have arrived at the point where we can truthfully say that the interruptions to our service are no greater, nor more frequent at the present time than was the case when steam was in use.

But we are not prepared to state there is any economy in the substitution of electrical traction for steam, on the contrary we believe the expense is very much greater.

You will appreciate that three or four months' successful operation of the trains of a standard railroad by electricity does not constitute in itself a sufficient test to warrant its extension or introduction elsewhere. The present service should stand the test not only of four summer months but of a winter's operation as well. There may yet transpire many things that will need remedies to be applied, as there have thus far, to enable us to reach the present stage, and we should deplore any agitation looking to the further establishment of electrical traction upon other sections of our system until after we have had a full year's operation of our present installation.

We believe no mistake will be made by the public in waiting a while longer for the installation of electric traction upon the railroads in the vicinity of Boston, for by such waiting the vexatious delays and embarrassments of experimentation will be avoided and the work and knowledge will have advanced to a stage that will result in a better installation in some respects and for a less outlay than has resulted from the pioneering in this system we have been obliged to indulge in on the west end of our lines.

The Boston & Maine R. R. reports through Mr. Lucius Tuttle, its President, stating that the results of its investigation "have not been such as to convince the company that electric motive power can be wisely or economically substituted for steam locomotives in the transaction of its business upon any part of its lines, especially its Boston terminals." The company is using coke-burning locomotives for a very large part of its local passenger service, and claims that there is very little annoyance from its locomotives.

The greatest interest in connection with the proposed electrification of Boston terminal lines centers on the Boston & Albany, which traverses a very densely settled district to reach its terminus. During the past year that company has made an investigation and estimate of the cost of installing electricity on two tracks from the Boston terminal over the main line to Riverside and return over the Newton Circuit. Investigation shows that a power station of 6,000 KW. would be required, with storage batteries to handle the peak load. The total cost of the installation is estimated at $4,600,000, and the interest, taxes and depreciation on this investment are assumed at 9%, or about $400,000 per annum. A stock argument for electric operation is the saving to be made in operating expenses, but concerning this the following statement is made:

Some slight economies would accrue in the transportation expenses under this operation, which would be substantially absorbed by the additional expenses to be incurred for the maintenance of the additional apparatus installed, and the net economies would be so small as to be inappreciable in the consideration.

Another stock argument of the advocates of electric locomotives is the growth in traffic which is supposed to result from electric operation. This argument is met as follows in the report:

Considering now the possibilities of increasing the traffic, the statistics of the Boston & Albany R. R. show substantially the following number of passengers handled in the above territory per annum:

1891	4,552,918	1899	3,897,364
1894	4,799,578	1907	4,435,841

This absence of any material increase in traffic is due probably somewhat to the fact that the circuit is occupied as a high-class residential district, not susceptible of rapid subdivision of property, and more particularly to the fact that suburban lines are being rapidly extended into all such outlying districts and afford a more advantageous means of collecting and distributing local travel through the commercial and residential districts than could possibly be afforded by a railroad constructed and operated upon private right-of-way and devoted largely to long haul operations.

As is well known, the Boston & Albany has had in the past few years to cope with increasing expenses and stationary income. Large outlays, in fact, have been necessary during the past year to put into fair condition a service which had become seriously defective. The proposition, therefore, to add an investment estimated at about $4,500,000 at the very lowest, the interest charges on which would be a perpetual burden on the system, is not an inviting one to the railway stockholders, and from a broader point of view its necessity ought to be well established before it is required in the public interest. The statement of the railroad company on this point is well worth reprinting:

It would therefore seem wise, before adopting a policy requiring an expenditure which is not only unremunerative, but which would mean a large annual loss, or radical increase in rates, that further investigations should be instituted, to see if some system might be devised to abate the nuisance complained of without jeopardy to the property, or without placing a large burden upon the public. The rapid evolutions which are being made almost annually in electric traction may soon afford a solution and the prospect of developing the steam locomotive itself is even more promising for the particular service which steam railroads have to perform.

I trust that it may not be considered inappropriate to mention at this time that the Boston & Albany R. R. is more urgently in need of other expenditures to protect its traffic and the best interests of Boston and the Commonwealth of Massachusetts.

As you are aware, large expenditures must be incurred in restoring the facilities at East Boston to maintain the prestige of the Boston port. Other considerable expenditures are required for enlarging warehouses, team yards, assembling yards, the construction of additional main tracks and the providing of numerous appurtenances for the economical and expeditious handling of traffic to afford good service, which we desire to give, and which the public require to protect their commercial interests, and it would seem desirable to make investments and issue securities therefor upon a conservative basis, in order that each investment may be self-sustaining, and the integrity of the property maintained.

We think it is worth while to call special attention to Mr. Mellen's statements, quoted above, as follows:

We are not prepared to state there is any economy in the substitution of electrical traction for steam, but on the contrary we believe the expense is very much greater.

Making all allowances for the fact that Mr. Mellen is speaking with an evident desire to delay the large expense which would be necessary if electrification of the Boston terminals of the New Haven system were undertaken, we think there can be little doubt in the minds of unprejudiced persons that his statement is substantially correct.

However notable from an engineering point of view the achievements in electrification of the terminal lines entering the Grand Central Station have been, it must be admitted that the results are not highly gratifying from an investment standpoint. A comparison of the present prices of New York Central and New Haven stock with those that prevailed before the transformation to electric operation was undertaken, is not a strong argument for the relegation of the steam locomotive to the scrap heap. It may be said that the introduction of electric traction had become a necessity under the conditions of the lines terminating in the Grand Central Station; but even if this be admitted, it follows that some similar necessity should be well established before railways terminating in other cities are compelled to undertake similar enormous outlays.

The idea is far too prevalent with the public, and even with some of the bodies which have been given legal power of supervision over railway companies, that any expenditure which can be forced upon the railway companies is so much gain for the public. Never was there a more absolute fallacy. In the long run, the cost of every bit of railway improvement must be paid for by those who buy tickets and ship freight. Economy in the administration of our railways is just as important in the interest of the general public as if the railways were actually under government ownership.

Admittedly, there is a certain nuisance inseparable from the operation of steam locomotives through a city, particularly when, as too frequently is still the case, the line runs through streets at grades; but in dealing with such cases of nuisance, we must always keep in mind the greatest good to the greatest number. If a change involves a capital expenditure of one or two or five million dollars, it ought to be well established that proportionate benefits are to result, justifying an expenditure of such a large amount.

Nor may the interest of the traveling public be overlooked. Suppose, for example, that the desires of Philadelphia and Baltimore and Washington were all gratified, and trains were operated within their limits solely by electric locomotives. A through train from New York to Washington then would start out with an electric locomotive from the New York terminal, would change to a steam locomotive in the outskirts of Newark, would change to an electric locomotive as it neared Philadelphia, would again change to a steam locomotive as it passed beyond that city, would have two more changes on either side of Baltimore and a final one as it approached Washington. In other words, for the run from New York City to Washington, six changes of locomotives would be required. Even with the best management these half-dozen changes would consume a very considerable amount of time. As regards the operating expense, too, it must be borne in mind that the introduction of electric traction on a short section in the neighborhood of a city will entail increased cost, with hardly any offsetting economies.

It will be said, of course, by electric enthusiasts that the solution will be found in the complete equipment of the line for electric operation throughout. While this may perhaps come in time, there is no immediate prospect that such a change would be financially practicable or desirable.

LETTERS TO THE EDITOR.

Renewing Rails.

Sir: Will you kindly advise what is the best American practice in relaying rails where there is an appreciable difference between the bases of the old and the new rail (as much as ⅝-in.). This is in regard to the number of lines of spikes that should be pulled, and the insertion of the number of lines of spikes replaced after relaying. I refer to track on tangents and on curves, where no tie-plates are used.

In the relaying, it is the thought that it should be done as expeditiously and as economically as is possible, maintaining after the relaying the same gage as was held by the old rails. Yours truly,

"Atlantic."

[In laying new rails which have a wider base than the old rails, two lines of spikes must be pulled. These will be the outer spikes for one rail (the outer rail on curves) and the inner spikes for the other rail. Then the distance between the center lines of the new rails will be the same as for the old rails. In many cases, however, the gage of the old track has widened, or the new rails have wider heads. In order to give the proper width of gage, three lines of spikes must be removed. On curves, the line of spikes left in place must be that on the outside of the outer rail. The new outer rail is first placed and secured. Then the position of the new inner rail is determined by a track gage held against the outer rail. If necessary, the ties must be adzed or trimmed to give even rail seats for the new rails. From Tratman's "Railway Track and Track Work" we quote as follows:

If the new rails have the same width of base and head as the old ones, all the outside spikes may be removed, the inner spikes being loosened, so that the old rails can be lifted out and the new ones slipped in against the spikes. As there is generally some difference in the rails, however, due to a variation in section or to the wear of the old rails, the outside spikes may be drawn on one side of the track and the inside spikes on the other side, so that the new rails can be spiked to gage. Three rows of spikes may also be drawn for this purpose. Where the new and old rails meet, care should be taken that the heads are in the same line, gage and level. * * * No train should be allowed to pass unless each rail has at least four inside and six outside spikes (or half the number of spikes on curves), and

each joint has at least the two middle bolts in place and properly secured.

McHenry's "Railway Location and Construction," containing rules used on the Northern Pacific Ry. (1903), says more categorically

In order to maintain the standard gage, three lines of spikes must be drawn if old steel rails are replaced by rails of wider section.

And of course also specifies that rail cut ties must be adzed to uniform bearing; that old spike holes must be plugged, and that spikes must be driven in the best wood in the tie and not in old holes.—Ed.]

The Specifications for the Pearl Harbor Dry Dock.

Sir: Pearl Harbor, near Honolulu, is to have the largest masonry dry dock in the world, but like most other masonry dry docks, which have been constructed by the United States, it is going to require at least 100% overtime and will probably ruin the contractor who attempts to build it.

The Bureau of Yards and Docks of the Navy Department has a sad record of failures and delays and adverse law suits in the Court of Claims. An important decision in said Court of Claims is shortly to be expected in the matter of the contract for the Philadelphia dry dock, and the relative responsibilities will be clearly set forth in that decision.

It would appear on the face of the Pearl Harbor specifications that the Bureau, instead of endeavoring to avoid the unbusinesslike tangle with contractors which has resulted in previous contracts, has specified conditions that absolutely prohibit successful compliance, and has, therefore, made it impossible from the start to prevent the delays and difficulties heretofore usual.

This Pearl Harbor dock is to be about 1,150 ft. long with a gate in the middle of its length to enable two big ships to be handled separately in it. The quantities of excavation and of material required are practically double the quantities of the largest masonry docks heretofore constructed. The location of the dock is more remote than any other so far contemplated by our government. The skilled labor market at hand is extremely limited, and the freight charges on all plant and materials will be far in excess of previous expense.

Notwithstanding all of this, *the time of construction* allowed the contractor is only 32 months from the date of the contract. No other masonry dock of half the size has been constructed under 48 months, hence the contractor would have to figure on about three years' overtime at a penalty of $100 per day, to be reasonably safe in his estimates, and even that is not enough protection.

The contractor is liable to have his contract taken away from him at any time after 32 months have expired, and many other equities would become a matter of discretion with the Chief of the Bureau of Yards and Docks under such condition of overtime construction.

Moreover, the enormous item of foundation piles to the amount of about 20,000 is still unsettled. The contractor is not to include them in his main bid, but they are shown in the plans and may be ordered into place at an extra unit price as directed by the Chief of Bureau, and to any extent from one pile to twenty thousand.

The foundation soil is coral, sand, and rock in unknown distribution and extremely porous. The probable penetration of any foundation piles cannot be guessed at. They may not be needed at all, and if needed the length can only be determined by driving very numerous test piles as the bottom is laid bare, and only then can the pile supply be ordered with any reasonable accuracy.

The writer thoroughly believes that, if the piles shown on the plan were found to be necessary, the entire job of pile driving and preparation for the laying of concrete, in addition to the excavation and cofferdamming, would alone reasonably require the entire contract time given by the specifications.

Three years from Feb. 13, 1909, the writer, if living, will call the attention of your readers again to this matter and claim his success or admit his failure as a prophet.

Yours very truly,

"Tax Payer."

New York, Dec. 28, 1908.

[In order to present the other side of the case we have made inquiries of the Washington authorities respecting the matters discussed in the above letter. It is admitted that there have been a number of unfortunate delays in the construction of the Government dry docks, but the blame for these is laid upon the contractors. In the case of one particular dry dock it is stated that a contract was originally let for its construction in July, 1899, but the contractors after much controversy with the department and the failure of two cofferdams were declared in default. The contract was relet; but the new contractor, while showing much energy at the start, encountered financial difficulties and consequent delay. The Receiver for this second contractor, however, began laying concrete in the dock on March 2, 1908, at which time the structure was rated as 38.518% completed. On Dec. 28 almost all the concrete, estimated at 68,754 cu. yds., had been laid and the work was ranked as 75.25% completed.

Regarding the Pearl Harbor dock, the need for it is considered to be so great that the utmost haste is desired in its construction. It is admitted that bids are called for before all the information desired is at hand; this is done in order to hasten the work. Regarding the piles, it is not possible to tell certainly whether they will be needed and how many until the excavation on the site is well advanced. The contractor is asked to bid a unit price on so many of these piles as may be found necessary.

With regard to the time of completion, if any contractor deems the time of 32 months too short for completion, he is at liberty to modify it in submitting his bid. The Government seeks the most favorable proposal both in time of completion and price for the work, and if the bids are unsatisfactory may construct the dock by day labor.

The amount of skilled labor necessary for dry dock construction is not large and there is plenty of common labor available in the Islands and on the Pacific Coast. Materials for concrete, with the exception of cement, are easily obtained, and cement can be readily obtained from California.—Ed.]

The Mattress vs. The Neale System of River-Bank Protection.

Sir: The two numbers of Engineering News for Dec. 10 and 17, 1908, reached me yesterday, and I have read the letters of Mr. De Witt and Mr. Miller on "River Protection." I have been an engineer for 30 years, and saw the trial of the "Weed" dike on the Missouri in the seventies and have watched most of the other and later attempts to curb our streams. Hence these few remarks.

The gentlemen in this correspondence, and any others who will go to Cairo, Ill., can see a very fair test of the two forms of protection. At Eliza Point, just above Cairo, the bank was protected by mattress and revetment in 1881. The river attacked this point with such fury that its width was reduced to 750 ft. The work has held the river, and has had few repairs, and was in 1905 in good condition. The repairs have been limited to replacing stone displaced by ice. On the opposite side of the river at Bird's Point the David Neale system was used in 1904. An officer of the road at the time is my authority for the statement that Mr. Neale was given over 50% more money than he asked for at the start, and one year later not a vestige of his work could be found with a 50-ft. sounding line. It was my understanding that the St. L., I. N. & S. Ry. had expended at Bird's Point a larger sum than that which saved Eliza Point.

Mr. Miller refers to the work at Pine Bluff, Ark. If he will refer to the report of Capt. Taber for 1885, he will find that the river front at that place was protected at that time by a very close imitation to the Neale system. The washing away of the dikes at this place has been foreseen for at least three years, and the attention of various people has been called to it. The value of the fascines in saving the water front there are of doubtful value. They were of help, but if the river had not of itself cut across the point opposite the city, and diverted the current, these fascines would have probably been of no more benefit than were the efforts at Bird's Point.

Mr. Miller shies a few rocks at the work of the Missouri River Commission, although it is not named. I think it is the belief of all who have studied that river that if the plans of Major Sutor had been followed by his successor the history would have been differently written. An experiment was tried, but not in the way Major Sutor had planned, and the appropriations for a few years made only islands where the stone used in the experiment remained, and added somewhat to the silt of the river.

I have worked on the Mississippi from the Jetties to Lake Winnebegoshish, and have done a little on the Wisconsin, Missouri, Platter, Arkansas and Red. I have yet to find where a mattress type of protection failed if it were carried to the thalweg of the stream and carried above and below the point of attack. I have found no other type which was any permanent protection. Permeable dikes are good while they last, if they are placed close enough together to prevent eddies forming below them.

Assistant Engineer.

Pine Bluff, Ark., Dec. 19, 1908.

We referred the above letter to Mr. Miller and append his reply as follows:

Sir: With reference to the revetment work at Eliza Point, just above Cairo, which is cited in the letter above, the following is gathered from the several reports of the various Engineer Officers in charge of that work. After following the earlier reports wherein the original work and necessary repairs are detailed, we note in the report for the year 1899, that the total amount expended to June 30, 1899, was $170,474.98; being at the rate of $10.69 per lin. ft. (The most of this total was expended previous to June 30, 1887; that report showing $100,439.82.)

In a descriptive article published in the report for 1907 we note that 10,700 lin. ft. of revetment was built during 1876, 1878 and 1879 in and between the stone spur dikes built by the Cairo Land Co. many years before. In 1881 the channel shifted to the west side of the middle river bar at this place, and the accretions formed thereafter in the bend connected the bar with the main land, and the whole became Eliza Towhead. Since 1896, owing to changes above, the river is again attacking this point; and for the protection of these accretions, which are regarded as adding 1,000 to 2,000 ft. of bank width, the U. S. Government began to protect the same; placing 1,083 lin. ft. in detached sections so as to protect 3,100 ft. of bank.

It would seem from this that the reason why the original work remained in place without many repairs, was because the river left the greater part of the work soon after it was placed, and built up a sand bar in front of it.

Unfortunately we are unable at this date to definitely state how much money was paid to Mr. Neale for the protection work he placed at Birds Point; but his unit price was $4.50 per lin. ft. of bank protected, and it is hardly possible that there could have been more than 2,000 ft. of bank worked upon; making a total of $10,000.

Previous to the time Mr. Neale began work, the railroads had expended several thousand dollars in haphazard fashion, but mostly for riprap work at the "point" in the extreme lower end of the bend.

During 1903-4 the Government placed in the neighborhood of 2,000 lin. ft. of revetment in this bend just above the David Neale dikes, at a cost of $16,400. The total expended by all parties in the Birds Point bend is a very small part of the total used in the Eliza Point work.

Recent reports show that in addition to all of the work placed by David Neale and the railways, that fully one-half or more of the Government mattress was lost during the recent high water season. The trouble is not with the methods of construction, but due to the failure of all concerned to make repairs at the proper time.

The conditions at Pine Bluff are very severe on account of the conformation of the river in that vicinity. This fact seems to have been recognized by the Engineer Officer in charge, who, in describing his plans for the work, makes the following statement in the report for 1905, referred to above. "The first thing done was to secure an Assistant Engineer who was known to be a lion-hearted builder."

It is questionable whether the dike system should be used under the conditions cited; viz., a very sharp bend in the course of the river, with a cutting point opposite the dikes, permitting the river to attack between the dikes as the caving of the point progresses. But the record of this protection work is very good when compared with other work of the same class. The dikes built in 1885 were repaired and strengthened from time to time up to 1893-4 when considerable mattress work was added; since that date very little has been spent at this point; the work proving effective up to the time of the recent very severe floods; and had those in authority taken measures to repair the work, the washing away of the same, which has been foreseen for at least three years, would not have occurred.

There was no intention to "shy a few rocks at the work of the Missouri River Commission" because they undoubtedly carried on the work in an economical manner, and in accordance with the best plans in vogue at the time; all in so far as they could control. It is merely contended that in so far as our limited knowledge goes, the David Neale system can be used with much economy under the ordinary conditions obtaining on the silt bearing streams.

We are today using other plans and systems of protection work, each problem being handled independently, and under the plan affording the needed protection with the least expenditure, having in mind future requirements, and are not attempting to place permanent improvements to the river as such, but merely protecting our embankments from further encroachments.

As stated in a previous letter, the records do not bear out the inference contained in the last paragraph, that the mattress type of protection is permanent.

Yours very truly, Chas. H. Miller,

Engr. River Protection, Mo. Pacific Ry. Co.

Little Rock, Ark., Jan. 8, 1909.

The Failure Under Test Load of a Reinforced-Concrete Reservoir, Annapolis, Md.

By R. H. DANFORTH.*

During the loading test of a concrete storage reservoir at the U. S. Naval Academy, Annapolis, Md., on Dec. 21, 1908, the section of the roof surrounding the load collapsed, due probably to a rather unusual shearing of the column footings. The reservoir is one of four, each 100 ft. long, 50 ft. wide, 11 ft. deep, with a capacity of 412,000 gals. It had over it a concrete roof 5 ins. thick, supported by columns arranged as shown in Fig. 1. The floor of this reservoir is 4½ ins. thick, reinforced by 4-in. × 12-in. mesh, Clinton wire cloth, wires being No. 8 and No. 10 gage. The columns were 9-in. × 11-in. and were set on footings 48 ins. × 48 ins. 16½ ins. deep, thus bringing the excavation for the footings to 12 ins. below the general floor level. There was no extra reinforcement in these footings, but the wire cloth was run through the footings and pressed down as near the bottom of them as possible.

The reservoir is about 250 yds. from tide water, and the under side of the floor is 4 ft. above mean low water mark. The ground on which it is built is a fine sandy clay, which holds moisture like a wet cloth, but as a similar reservoir had been built immediately adjacent to the new work about two years ago, no fear of the foundations was felt by the engineers in charge who based the design upon that of the former structure with slight modifications.

During the excavation for the new reservoir the wall of the old one, weakened by the removal of the earth backing, cracked in several places, letting about 350,000 gals. of water into the excavation and on to the foundation of the new work. This was pumped out as soon as possible, but undoubtedly had its effect on the clayey soil under the new structure.

About three weeks after this flooding occurred the concrete for the floor and footings was placed, the ordinary precautions as to removing mud and water from footing holes being observed. The concrete was machine mixed of 1:2:4 proportions, placed with hand cars of 9 cu. ft. capacity, and although the ground seemed rather soft in places it was thought that a good job had been made. This sealing up of the foundation prevented any further evaporation of the moisture therein.

The work progressed at a normal rate and was completed on Nov. 19. On stripping the forms a week or two later an exceptionally smooth job was revealed, which required no plastering or patching, although for waterproofing purposes the floors and side walls were washed with cement grout.

A permanent earth fill 2 ft. deep was placed on the roof about the middle of December. This made the load on column footings, as figured by the contractor, 3,300 lbs. per sq. ft. To fulfill the requirements of the specifications, on Dec. 21, a test load, consisting of an additional 2 ft. of earth was hauled onto the bay indicated on Fig. 1, being placed with drag scrapers. This made the estimated load on column footings 5,000 lbs., or 2½ tons, per sq. ft.

During this loading levels were taken at frequent intervals on the rims of manholes A, B and C, Fig. 1, to note deflections, if any. The

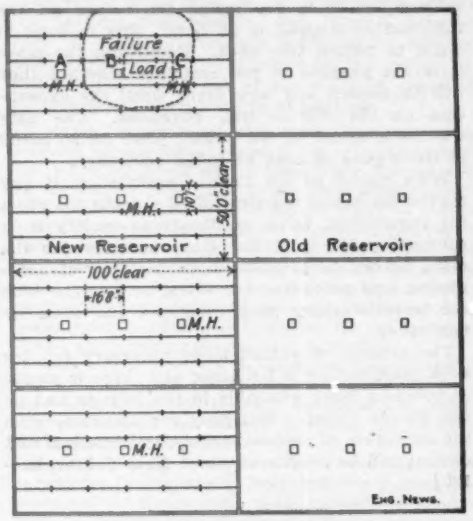

Fig. 1. Plan of Annapolis Reservoir.

depression at manhole A, very slight at first, increased until about 5 minutes before the failure, when, on the one side away from the failure, it was ⅛ in., while on the side west of the break it was 1½ ins. These points are about 30 ins. apart. At manhole C the maximum depression was about 1¾ ins. on the side away from manhole B, while on the side next manhole B it was 2¼ ins. about 5 minutes before the break occurred. At manhole B at the same time a depression of about 2½ ins. was observed, and sufficient observations were taken to show a steady settlement of about 2 ins. per hr.

About 10 minutes before the failure an examination of the interior of the reservoir was made, which showed a depression of column footings either side of manhole B and evidences of cracks round several other columns, with considerable water coming up through the cracks in the floor, showing the excessively wet foundations.

An examination since the failure shows distinct shearing round the foot of the three columns between manhole A and the break, with the same appearance, but less marked, in all the remaining columns adjacent to the broken portion. The column in the corner of the reservoir was pulled down, in its fall stripping the reinforcement from its girder, as is shown in Fig. 2, where the head of the column is seen suspended by the girder reinforcement. In this half-tone also can be seen a pool of water around the foot of the center column and a line of moisture some 2 ins. above the floor, all of which has come up from the foundation.

The photograph (Fig. 3) is taken from a point near manhole A and gives further evidence of the good quality of concrete used. The column in the center of this figure has settled about an inch, and has a crack completely round its base nearly wide enough to put one's finger into, and apparently going completely through the footing. Unfortunately the poor light made it impossible to show this in the illustration. Fig. 3 also shows clearly one of the characteristic features of this failure; a large portion of the floor slab remained intact, a break occurring at each joint in the reinforcement, and at the edge of the failure where in most cases the reinforcing rods held the slab up, making a nearly complete wall round the damaged portion, while the portion which came down onto the floor makes any investigation of the cause of the disaster very difficult.

For the benefit of those interested in the details of the design, the following information is tabulated:

Floor Slab.—5 ins. thick, reinforced with ½-in. N. S. Johnson bars every 6 ins., bars running at right angles to girders, spanning 2 bays and lapping over a girder. Bars 1 in. from bottom of slab.

Girders.—19 ins. × 8 ins. Reinforcement, 4 1-in. Johnson N. S. bars, two being straight and two bent up at the third points and extended about 4 ft. beyond columns into adjacent girders with 4¼-in. stirrups at each end. The stirrups were extended into the floor slab several inches. There was 2-in. concrete under the reinforcement.

Columns.—9 ins. × 11 ins. and 11 ft. high. Floor to under side of roof reinforced with four ⅞-in. Johnson N. S. bars set 1 in. in from face and hooped with ¼-in. bars every 12 ins.

In Fig. 2 will be noted a characteristic girder failure, which shows that shear occurred along the plane of the reinforcement. This is evidently due to the close placing of four 1-in. rods in a beam only 8 ins. wide, although had the column foundations been sufficient this feature would probably not have developed.

Fig. 2.

Fig. 3.

VIEWS OF INTERIOR OF REINFORCED-CONCRETE RESERVOIR AT U. S. NAVAL ACADEMY, ANNAPOLIS, MD., AFTER FAILURE UNDER TEST LOAD.

*Mechanical Engineer, U. S. Naval Experiment Station, Annapolis, Md.

THE DEPTH AT WHICH WATER PIPES FREEZE is being investigated by a committee of the New England Water Works Association, of which Mr. F. A. Barbour, 1120 Tremont Building, Boston, Mass., is chairman. The committee has sent out a very detailed schedule of inquiries relating to the depth of laying water-pipes and experiences with freezing. Those who desire to assist in this thorough-going investigation, a subject of great importance to water-works men of the country, may obtain copies of the circular, if they have not already received them, by addressing Mr. Barbour as above.

Annual Meeting of the American Society of Agricultural Engineers.

By CHESTER O. REED.*

The American Society of Agricultural Engineers held its second annual convention at the University of Illinois, Dec. 29 and 30. The large attendance of the leading men of the profession, prominent implement manufacturers and farmers showed the interest manifested in the new organization.

The Society was formed a year ago at Madison, Wis., the organization being brought about by the realization of men who are engaged in teaching Agricultural Engineering in our universities, and of those actively engaged in the profession, that the most extensive work was yet to be accomplished in agriculture along the lines of research in irrigation, drainage, farm buildings, farm conveniences and farm machinery.

Implement manufacturers favored such an organization, for they realize that a closer relationship must exist between the producer and user of tools which have in the past few years revolutionized farming. They realize that such relationship can best be fostered through the Farm Mechanics Departments of our Agricultural Institutions, these in turn being reached and the alliance placed on a firm basis through the society mentioned.

The government also realized the importance of the movement on foot, and its representative was present at the birth of the Society.

The address of the late President of the Society, Prof. J. B. Davidson, of the University of Iowa, follows in part:

The past decade has witnessed a wide extension of engineering into agriculture. It is engineering that has been one of the chief factors in raising agriculture to the high standard it has attained. This has been brought about by machinery utilizing power other than human power, by better farm buildings, better field and sanitary drainage, more adequate water supply, improved methods of securing and applying irrigation water, and good roads,—all phases of engineering. With a good training in agricultural engineering the agricultural worker will be better equipped to cope with the world's problems. The engineering training demanded today in the successful management of a modern farm, as well as a thorough knowledge of engineering subjects is absolute evidence that this branch of agriculture must and will be given a more important place in the agricultural college curriculum.

Arguments will be advanced that all phases of agricultural engineering are included in the present societies, but engineering has become such a complex subject and has reached a high degree of development in the older branches that Agricultural Engineering is practically excluded. The extent and magnitude of the interests upon which Agricultural Engineering is dependent are enormous, and the fact that these interests are scattered makes a more difficult problem. I contend that drainage, irrigation and highway engineers are Agricultural Engineers.

Persons eligible to membership in the American Society of Agricultural Engineers are those who are actively engaged in some line of engineering closely identified with agriculture. Under this provision the Society could rightfully include in its membership all those engaged in farm implement design and manufacture, architects of farm buildings, drainage engineers, irrigation engineers, highway engineers and those who have training for operating large interests in which these various lines of work are involved.

Throughout the sessions addresses were given and papers read by the Professors of Agricultural Engineering in various universities, describing the character of the lines of work pursued by each, their methods of instruction, results of research and suggestions for improvement.

That extension work in Agricultural Engineering is demanded was clearly shown, and specific examples were cited by men who have been engaged in studying the farmers' conditions, where relief could only be looked for from the Agricultural Engineer.

Mr. M. L. King, of Iowa, spoke on "Some Pressing Agricultural Problems," in part as follows:

The nature of strictly agricultural engineering problems are such that a special agricultural knowledge is necessary to solve them. The boundary is indefinite in places, but still is logical as it includes a large number of problems which have hitherto been either largely neglected, or wrestled with in a haphazard fashion by the individual whose methods are unscientific—by scientific methods I mean those which produce the desired result consistently. These problems usually pertain to an individual farm and are such as would be overlooked or not seen by an engineer who is not an agriculturist.

Only by hearty cooperation may we hope to rapidly solve the problem at hand. That is the builder and designer, the user and educator must come into such close proximity as was never necessary in any other form of engineering.

The government representative, Mr. R. P. Teele, spoke on "The Need of Work in Agricultural Engineering by the National Government." He first outlined the methods and policies of the Department of Agriculture, following with suggestions which he wished discussed by the Society, it being the policy of the government to procure the ideas and suggestions of men actively engaged in Agricultural Engineering extension work. Mr. Teele showed that buildings, implements and machinery together represented 25.1% of the fixed capital of the farmer and that the Department was doing almost nothing to aid improvement in this field.

The government fully realizes that attention must be given to the problems of Agricultural Engineering, but the question arises as to whether the work should be accomplished by simply extending present systems or by establishing a new bureau in the Department of Agriculture, known perhaps as a Bureau of Agricultural Engineering with the proper divisions for Drainage, Irrigation, Farm Machinery, Farm Building, etc. Such a plan as the latter has been recommended by the Office of Experiment Stations, but Congress has feared that such a bureau would be involved sooner or later in advertising complications.

The outline for a course of study in Agricultural Engineering, as prepared by the National Committee, was read and discussed with the result that a committee was appointed to study this course as given, with view of improvement and report to the National Committee.

A second committee was appointed to study the conditions warranting the establishment of a new bureau and to report to the National Committee.

Mr. E. W. Hamilton, Winnipeg, Canada, described "The Motor Contest" held at the recent Winnipeg Industrial Exhibition. Mr. Hamilton showed conclusively the great benefits of these contests to farmer and manufacturer, and giving the rules of the contest and plans for the future. From his statements we are assured that the contests have taken a long step toward the standardization of farm traction.

Professor Ocock, of the University of Wisconsin, led the discussion, calling attention to the advantage of gasoline traction over steam. By interesting data he showed that it cost $20 per day to operate a steam traction engine against $12.70 for the gasoline, and that where the former is used, 24% of the time is consumed in taking on fuel and water. The excess of weight of the steam traction over gasoline machines was claimed as also a decided disadvantage.

Mr. J. F. Steward, of the International Harvester Co., emphasized the importance of mechanical training for the farmer, stating that when the farmer learned to properly operate a machine, the manufacturer could place a more efficient and yet less expensive one on the market.

President Bartholomew, of the Avery Manufacturing Co., showed the possibilities that the farmer might improve his own machinery and the type of machinery generally if he were able to present his ideas in a tangible form that the manufacturer could use.

Mr. Bartholomew said in conclusion:

There is an awful waste of thought and energy. Thousands of really good things come to naught simply because the man had neither the time nor brains to bring his inventions into tangible form. If these matters could be gathered up and the colleges could give them to their students when they reached the point that would justify it, as a matter of practice they could make drawings and bring the invention out, and it would be a great assistance to the student engineer and to many farmers and users of machinery who have really good ideas, but neither time nor money and I might say the "know how" to put their inventions in tangible form.

At the business session the following officers were elected for the ensuing year:

President, J. G. Wynne, of the Northern Electric Co., Madison, Wis.

First Vice-President, Prof. C. A. Ocock, University of Wisconsin.

Second Vice-President, R. P. Teele, Washington, D. C.

Secretary, Prof. L. W. Chase, University of Nebraska.

Treasurer, E. A. White, University of Illinois.

The third annual convention will be held at Ames, Iowa, in December, 1909.

*Farm Mechanics Department, College of Agriculture, University of Illinois, Urbana, Ill.

The 22d Annual Report of the Interstate Commerce Commission.

From advance sheets of the annual report of the Interstate Commerce Commission, submitted to Congress on Jan. 11, the following abstract has been prepared:

RAILROAD EARNINGS FOR 1908.—The temporary financial depression from which the country is now emerging resulted in the diminution of railway revenues considerably below the high point reached in 1907, the banner year in American railroad history.

In view, however, of the widely circulated reports that the loss inflicted upon the railroads was so severe as to warrant universal advances in rates or reduction in wages, or both, it is interesting to note that the gross earnings of all railroads for 1908, although $164,464,941 less than the gross earnings for 1907, were $98,875,470 in excess of the gross earnings for 1906 and $342,158,231 in excess of those for 1905.

The net earnings for 1908, although $111,051,000 less than for 1907 and $30,349,138 less than for 1906, were $37,658,504 in excess of those for 1905.

THE HARRIMAN DECISION.—In E. H. Harriman vs. Interstate Commerce Commission, decided Dec. 14, 1908, the Supreme Court of the United States held, reversing the decision of the Circuit Court, that the appellant could not be required to answer certain questions propounded to him by the Commission. This decision has a somewhat important bearing upon the work of this body which Congress should understand.

The Commission had instituted upon its own motion an inquiry into railroad consolidations and combinations, which had been prosecuted with special reference to the operations of Mr. Harriman in connection with the Union Pacific, the Southern Pacific, and allied interests. In the course of this investigation it came out that the Union Pacific, in which Mr. Harriman was the dominant factor, had purchased of the Chicago & Alton and Illinois Central certain very large blocks of stock, and he was asked whether he had a personal interest in the stocks of these companies purchased by the Union Pacific. It appeared what the price paid by the Union Pacific was, and Mr. Harriman was also asked in one instance to state, in case he owned any of the stock thus purchased by the Union Pacific, what price he had himself paid for the same. These questions he declined to answer, and in this refusal he is now sustained by the court.

This Commission in administering this power of investigation, which it has assumed to exercise in the past, has repeatedly held that the private dealings of individuals in private matters could not be inquired into. It has, however, ruled that it might inquire to the fullest extent into the operations of railroads and the officers of railroads. The Union Pacific R. R. is not a private enterprise—it is a public servant, discharging, as the agent of the Government, a public function. Its stocks are worthless except as they derive value from the charges which are imposed upon the public for the rendering of this public service.

In the opinion of this Commission, when Mr. Harriman assumes control of the Union Pacific R. R. he ceases to be a private individual to that extent and can no longer claim protection, which, as a private person engaged in a strictly private pursuit, he might insist upon. It was our opinion that he might properly be required to state whether as an individual he had sold to the Union Pacific, which he controlled, stocks belonging to himself, and if so, that he should further be required to state what profit he had individually made out of this transaction. If this gentleman is allowed to accumulate from the manipulation of these public agencies vast sums of money which must finally come from the body of the people, we think he is so far a trustee of the people that he cannot object to stating the manner in which these accumulations have been made.

The Supreme Court, however, is of the contrary opinion, and the Commission can of course only suggest to Congress that if there is to be any full investigation by the federal authorities of these financial dealings some action must be taken by the Congress.

COMPLAINTS BEFORE THE COMMISSION.—During the year 5,194 complaints, formal and informal, have been filed with the Commission for consideration and action, relating to the rates and practices of substantially all

railroads in the United States. The number of formal cases and investigations instituted during the year was 554, or an increase of 33⅓% over the previous year.

Attention is called to the radical difference between decisions of the courts and of this Commission, in that the ordinary court decision involves only the rights of the parties to the case, whereas any important readjustment of rates applies not only to complainant but also to all shippers under those rates, and frequently, as a commercial necessity, to carriers who are not before the Commission in a particular case, and therefore, the proper discharge of its duties by the Commission requires consideration, not only of the facts before it, but of the probable commercial effect of its orders upon communities, carriers, and shippers who are not represented in the particular case.

SUITS BY CARRIERS TO ANNUL ORDERS OF THE COMMISSION.—Previous to July 1, 1908, only a single suit had been filed to set aside an order of the Commission. It is, however, a significant fact that since that date 16 suits have been begun for that purpose, and few orders of important significance have been permitted to go without contest. The questions presented by these various suits are fundamental. The constitutionality of the act itself is in issue. The right of Congress to delegate to any tribunal authority to establish an interstate rate is denied. Perhaps the most serious practical question concerns the right of the courts to review the orders of the Commission. If the contention of the carriers in this latter respect alone is sustained, but little progress has been made under the Hepburn amendment toward the effective regulation of interstate transportation charges.

In 12 of the 17 cases preliminary injunctions were prayed for, being granted in 6 and refused in 6. It has been from the first well understood that the success of the present act as a regulating measure depended largely upon the facility with which temporary injunctions could be obtained. If a railroad company, by mere allegation in its bill of complaint supported by ex parte affidavits, can overturn the results of days of patient investigation, no very satisfactory results can be expected. The railroad loses nothing by these proceedings, since if they fail it can only be required to establish the rate and to pay to shippers the difference between the higher rate collected and the rate which is finally held to be reasonable. In point of fact it usually profits, because it can seldom be required to return more than a fraction of the excess charges collected.

All these cases are proceeding under the expediting act. Several of them are before the Supreme Court of the United States for argument already, and the rest will be at once taken there. It is believed that the decisions of that court in these cases must go far toward determining the effectiveness of the present act; and, indeed, *the possibility of any effective railway legislation under the present Constitution of the United States.*

RESTRAINT OF RATE ADVANCES PENDING PROCEEDINGS BEFORE THE COMMISSION.—In its last annual report attention was called to the fact that the Commission has no authority to restrain an advance in rates or to change a rule or regulation which imposes an additional burden. Railways may establish whatever interstate rates they choose. No proceeding can be begun before the Commission until the schedule establishing the rate has been filed. The order of the Commission when made cannot take effect in less than thirty days. If the investigation is to be one in reality as well as in name, if all parties are to be heard as they should be, several weeks, and usually several months, must elapse before a conclusion resulting in an order can be reached. Meantime the rate established by the carrier remains in effect. No carrier should be required to reduce its rates without a fair hearing; neither, in the Commission's opinion, should the public be required to pay advanced rates without opportunity for a fair hearing.

In several cases courts have granted injunctions against changes in rates pending proceedings before this Commission, but such injunctions have run only in favor of complainants, with the result that at the present time these carriers have established and are collecting one rate under their tariffs, and, under an order of court, are collecting another rate from parties to the proceeding. The jurisdiction of the courts to grant such injunctions is vigorously combated by the railways, and very difficult questions arise where the several carriers making up the through line are in the jurisdiction of different courts. As a practical matter, in such proceedings the small shipper who cannot file bond to secure an injunction cannot and does not continue in business under the higher rate. It would be easy to multiply instances and illustrations showing the confusion and discrimination which now exist in this respect. The Commission renews its recommendation of one year ago that it be given authority to restrain the advance of a rate or the change of a railway regulation or practice, pending the proceeding before it to determine the reasonableness of an advance or change, and it earnestly calls attention to the necessity for immediate action.

RAILWAY ACCIDENTS.—In the year ending June 30, 1908, there was a remarkable falling off in the number of casualties to both passengers and employees, due to some extent to diminished traffic on railroads generally. As appears from a summary published in the report, the number of passengers killed in train accidents was 165 in 1908, as compared with 410 in the previous year. There is also a gratifying decrease in the number of employees killed and injured. The number of employees killed in coupling accidents shows a reduction of 20% from the previous yearly record.

Attention is called to the necessity of legislation authorizing an investigation, under direction of the Commission, of train accidents, for the purpose of obtaining light on the question of preventive measures for the future.

SAFETY APPLIANCES.—With the possible exception of power brakes the condition of safety appliances is steadily improving. It is not clearly understood why the maintenance of the brakes does not keep pace with progress of improvement of other details of equipment, but it is probably attributable to the following situation: The sole requirement of the present law in regard to power brakes is that no train subject to the present act shall contain less than 75% of cars equipped with power brakes in operative condition. Cars not exceeding 25% of the total in the train may have their brake equipment "cut out" of the connection, and no liability ensues to the carrier if the remaining brakes are sufficient to control the speed of the train. There is an imperative need for regulation governing cars that are equipped with both hand and power brakes, operating in opposition to each other. Any action of Congress looking to this end will be of great and lasting value in promoting the safety of lives, limbs, and property.

BLOCK SIGNAL AND TRAIN CONTROL BOARD.—The annual report of this board to the Commission will appear as an appendix to the Commission's report [reprinted in this issue]. This board has indorsed the Commission's recommendation that legislation be enacted looking to the compulsory use of the block system.

REGULATIONS FOR THE SAFE TRANSPORTATION OF EXPLOSIVES.—In conformity with an act approved May 30, 1908, which required the Commission within ninety days from the passage of the act to formulate regulations for the safe transportation of explosives that should be binding upon all common carriers engaged in interstate commerce which transported explosives by land, the Commission prescribed regulations which became effective Oct. 15, 1908. It is believed that the regulations adopted, while avoiding undue restrictions upon the transportation of explosives, impose requirements which are shown by analysis of the various explosives and practical tests of their liability to explode during transportation to be absolutely necessary to their safe carriage as to the protection of other property and the traveling public. Such modification of the regulations as may appear necessary will be made from time to time in accordance with the terms of the act. The Commission submits for the consideration of the Congress, without recommendation, the propriety of amending the act of May 30, 1908, so as to authorize the Commission to make binding regulations for the safe transportation of inflammable articles and acids similar to those already prescribed in respect of explosives.

DISCRIMINATION.—Arrangements by which carriers farm out a portion of their duties to shippers generally result in discrimination. Under this heading may be placed the evils arising from private ownership of freight cars, the allowance paid by the carriers being frequently excessive. Elevators operated by shippers and furnishing a service covered by railroad tariffs usually result in more or less complete monopoly of the grain business passing through them. Lighterage arrangements when made between carriers and shippers are also means of discrimination. The ownership of cotton compresses by shippers and the treatment of their services as a railroad duty also works discrimination in the handling of cotton. Other like instances might be given. It is sufficient to say, however, that any use by carriers of instrumentalities owned by shippers in the performance of their obligations to other shippers usually results to the unlawful advantage of the owners of such instrumentalities.

The decisions of the courts during the year just passed have, with two or three exceptions, served to strengthen the law against discriminations.

The ruling of the Circuit Court of Appeals of the third circuit that the commodities clause of the act is unconstitutional has served to embarrass and delay the fight against discrimination. A considerable number of carriers are owners of and dealers in commodities carried by them. Such carriers succeed in practically every case in monopolising or at least dominating the markets in which they deal. The commodities clause by compelling carriers to confine themselves to the transportation business promises to give many shippers freedom from discrimination.

VALUATION OF RAILWAYS.—The Commission has in previous reports expressed the opinion that it would be wise for Congress to make provision for a physical valuation of railway property, and discusses at some length the various reasons which induce it to reaffirm its confidence in the wisdom of such a measure. Without making any specific recommendation, the report discusses the means of proper regulation of railway capitalization, and the Commission begs this opportunity of submitting to Congress its judgment that some adequate method of federal control over railway capitalization is required by the interests involved.

New Rail Specifications of the Pennsylvania R. R. System.

The long troubled rail situation, arising from the railways' demands for stiffer specifications, and consequent disagreements between railmakers and railways on both price and quality, has at last cleared up quite a bit through the acceptance of the Pennsylvania Railroad System's new specifications, on the part of the steelmakers. The railway company has ordered for 1909 delivery the large amount of 425,500 tons of steel rails under these specifications. No official statement of price is given, but it is believed that the price hitherto prevailing, namely $28 per ton, is maintained.

The amount of the order, if it were all 100-lb. rail, would lay about 770 miles of single-track, and if it were 85-lb. rail about 910 miles.

The specifications are reprinted below in full. It will be seen that the drop-test requirements have been made more precise than before, and apparently they are fair to both parties. The provisions for marking rails as to location in ingot, and for accepting rails which show pipe but are able to pass the drop-test, should in time furnish the railway company excellent data for judging the extent of harm done by piping and segregation.

Specifications.

CHEMICAL COMPOSITION:

1. The steel of which the rails are rolled shall conform to the following limits in chemical composition:

Bessemer steel rails:

	Lower Limit.	Desired Composition.	Upper Limit.
Carbon	0.45%	0.50%	0.55%
Manganese	0.80	1.00	1.20
Silicon	0.05	0.12	0.20
Phosphorus	...	...	0.10
Open-hearth steel rails:		*Classification A.*	
Carbon	0.70	0.75	0.83
Silicon	0.05	0.12	0.20
Manganese	...	...	0.80
Phosphorus	...	...	0.03
Open-hearth steel rails:		*Classification B.*	
Carbon	0.62	0.70	0.75
Silicon	0.05	0.12	0.20
Manganese	...	...	0.80
Phosphorus	...	...	0.04

PROCESS OF MANUFACTURE.

2. Ingots shall be kept in a vertical position until ready to be rolled, or until the metal in the interior has had time to solidify.

3. No "bled" ingots shall be used.

("Bled ingot"—One from the center of which the liquid steel has been permitted to escape.)

4. There shall be sheared from the end of the bloom formed from the top of the ingot sufficient discard to insure sound rails.

(All metal from the top of the ingot, whether cut from bloom or rail, is the top discard.)

5. In reheating, care shall be taken to avoid burning the steel, and under no circumstances shall a "cinder heat" be used.

("Cinder heat"—One in which the scale on the sides of the ingot becomes fluid.)

6. The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws, for a rail 33 ft. in length, of 6¼ ins. for 85-lb. section, and 6⅛ ins. for 100-lb. section. These allowances to be decreased at the rate of $\frac{1}{100}$ in. for each second of time elapsed between the rail leaving the finishing rolls and being sawed. The bars shall not be held for the purpose of reducing their temperature, nor shall any artificial means of cooling them be used between the leading and finishing passes, nor after they leave the finishing pass.

MECHANICAL REQUIREMENTS.

7. The name of the maker, the weight and type of the rail, and the month and year of manufacture shall be rolled in raised letters and figures on the side of the web, and the number of the heat shall be plainly stamped on each rail where it will not subsequently be covered by the splice bars. A letter shall be stamped on the web to indicate the portion of the ingot from which the rail was rolled.

8. The section of rail shall conform as accurately as possible to the templet furnished by the Railroad Company. A variation in height of $\frac{1}{64}$-in. less or $\frac{1}{32}$-in. greater than the specified height, and $\frac{1}{32}$-in. in width of flange, will be permitted; but no variations shall be allowed in the dimensions affecting the fit of the splice bars.

9. The weight of the rails specified in the order shall be maintained as nearly as possible, after complying with the preceding paragraph. A variation of ½ of 1 % from the calculated weight of the section, as applied to an entire order, will be allowed.

10. The standard length of rails, at a temperature of 60° F., shall be 33 ft. Ten per cent. of the entire order will be accepted in shorter lengths, varying as follows: 30 ft., 27½ ft., and 25 ft.; and all No. 1 rails less than 33 ft. long shall be painted green on

ends. A variation of ¼-in. in length from that specified will be allowed.

11. The rails must be free from injurious mechanical defects and flaws; shall be sawed square at the ends, a variation of not more than 1/32-in. being allowed; and burrs shall be carefully removed.

12. The rails shall be smooth on the heads, straight in line and surface, and without any twists, waves, or kinks; particular attention being given to having the ends without kinks or drop.

The heat straightening shall be carefully done, so that galling under the cold presses will be reduced to a minimum. Any rail coming to the straightening presses showing any sharp kinks or greater camber than that indicated by a middle ordinate of 4 ins. in 33 ft. will be at once marked as a No. 2 rail, and only accepted as such. The distance between the supports of rails in the straightening presses shall not be less than 42 ins.

13. Circular bole for splice bars shall be drilled to conform accurately in every respect to the drawing and dimensions furnished by the Railroad Company, and must be free from burrs.

TESTS AND INSPECTION.

14. One drop test shall be made on pieces of rail not less than 4 ft. and not more than 6 ft. long from each heat of steel. These test-pieces shall be cut from the rail bar next to either end of the top rail, as selected by the inspector.

The test-piece shall be placed head upwards on solid supports, 5 ins. radius, 3 ft. between centers, and both 85-lb. and 100-lb. sections shall be subjected to an impact test from a weight of 2,000 lbs. falling 15 ft.

The deflection for No. 1 classification rails must not exceed that indicated by a middle ordinate of 2 ins. in 3 ft. for 100-lb. section, and 2¼ ins. for 85-lb. section.

The temperature of the test-pieces shall be between 60° and 120° F.

Test-pieces shall be tested to destruction.

a) If a test-piece breaks without showing physical defects, two more pieces from the same heat shall be tested, and if neither of these pieces fails, all rails of the heat will be accepted as No. 1 or No. 2 classification, according as the deflection is less or more, respectively, than the prescribed limit. Separate records shall be kept of these tests.

If either of the second test-pieces fails, all the rails from the heat will be rejected.

b) If, however, the test-piece broken under test (a) shows physical defect, the top rail from each ingot of that heat shall be rejected; and

c) A second test shall then be made of a test-piece selected by the inspector from the top end of any second rail of the same heat. If this second test-piece breaks, the remainder of the rails of the heat shall also be rejected. If this second piece does not break, the remainder of the rails of the heat will be accepted as either No. 1 or No. 2 classification, according as the deflection is less or more, respectively, than the prescribed limit.

d) If the test-pieces, test (a), do not break, but when nicked and tested to destruction show pipe, the top rail from each ingot will be accepted as "Special" rails, either as No. 1 or No. 2, and a separate record made of the test. The remainder of the rails of the heat will be accepted as either No. 1 or No. 2 classification, according as the deflection is less or more, respectively, than the prescribed limit.

15. The drop-testing machine shall have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of not more than 5 ins. The anvil block of the drop-testing machine shall weigh at least 20,000 lbs., and the supports shall be part of, or firmly secured to, the anvil. The foundations for the anvil block shall be such as will meet the approval of the railroad Company.

16. Rails which, by reason of surface imperfections, are not classed as No. 1 rails, will be accepted as No. 2 rails; but No. 2 rails which contain imperfections in such number or of such character as will, in the judgment of the inspector, render them unfit for recognized No. 2 uses, will not be accepted for shipment.

17. Rails improperly drilled or straightened, or from which the burrs have not been properly removed, shall be rejected, but may be accepted after being properly finished.

18. No. 2 rails to the extent of 5% of the whole order will be received. All rails accepted as No. 2 rails must have the ends painted white, and all top rails accepted as "Special" rails under Paragraph 14 (d) must have the ends painted blue. All classes of rails must be kept separate from each other, and be shipped in separate cars.

19. Rails will be accepted and billed according to actual weights.

20. All rails must be loaded in the presence of the inspector.

21. For Bessemer steel, the makers shall furnish the inspectors with the carbon determination of each heat, and, also, two complete analyses which shall represent the average steel of each day's work, before the rails are shipped.

For open-hearth steel, the makers shall furnish the inspectors with the complete chemical analyses for each melt.

These analyses shall be checked from time to time by the railroad company's chemist, and, on request of the inspector, the makers shall furnish a portion of the test ingot for check analyses.

22. Inspectors representing the railroad company shall have free entry to the works of the makers at all times when the contract is being filled, and shall have reasonable facilities afforded them by the makers to satisfy them that the finished material is furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture, prior to shipment.

Approved by order of the President.

A. C. SHAND,
Chief Engineer.

December 10, 1908.
(Revision of Specifications of February 4, 1908.)

Progress of Excavation on the Panama Canal.

We publish herewith a table and diagrams of our own compilation showing the status of the excavation of the Panama Canal at the end of 1908. In order to get a definite basis of comparison, the figures are taken from the monthly

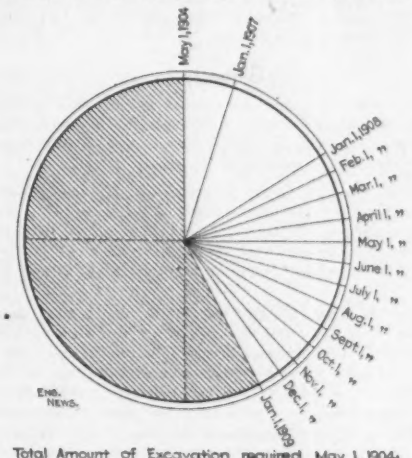

Fig. 1. Progress of Excavation on the Panama Canal under the United States, as Compared with Total Excavation Required.

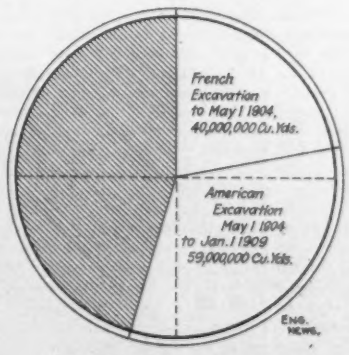
French Excavation to May 1 1904, 40,000,000 Cu. Yds.
American Excavation May 1 1904 to Jan. 1 1909 59,000,000 Cu. Yds.
ENG. NEWS.
Total Estimated Excavation,-including French,- 182,000,000 Cu. Yds.

Fig. 2. Diagram Showing Relation of French and American Excavation on Panama Canal to Total Estimated Amount.

items sent to headquarters at the beginning of each month, values that vary slightly from the final corrected amounts as shown by the totals. Thus, the Isthmian Canal Commission reports that the total American excavation has been 59,892,832 cu. yds., whereas the summation of the monthly amounts gives 59,980,987 cu. yds. This error is so small, however, that it is of no consequence when compared with the total required excavation.

It has been estimated that of the work done by the French companies up to May 1, 1904, the date of the American occupation, some 40,000,000 cu. yds. of excavation are utilized in the American plan. With the present accepted design the total excavation is estimated to be 182,000,000 cu. yds. (including the work done by the French), of which, according to the table, the Americans have taken out 60,000,000 cu. yds. Thus of the total amount the French did 22%, the Americans have done 33%, and there still remains to be done 45%. These figures are diagrammatically represented on Fig. 2.

Of the 142,000,000 cu. yds. to be taken out by the Americans, 5% was removed in 1904-06, 11% in 1907, 26% in 1908 and there remains 58% (Fig. 1). The table shows that satisfactory progress has been maintained throughout the year, with an average monthly excavation somewhat over 3,000,000 cu. yds. The effect of the rainfall is quite marked, as the record for March and April, 1908, demonstrates.

TABLE SHOWING PROGRESS OF EXCAVATION ON PANAMA CANAL MAY, 1904—DEC., 1908.

		Steam Shovels. Canal Prism.	Steam Shovels. Outside Prism.	Dredging. Canal Prism.	Dredging. Outside Prism.	Working Days.	Daily Excavation.	Rainfall ins.	Total Excavation.
1908.	Jan	1,583,386	175,276	904,633	46,298	26	104,330	1.15	2,709,613
	Feb.	1,657,481	178,404	1,065,406	25,835	24	122,745	0.43	2,927,126
	March	1,905,433	251,687	1,298,504	31,663	26	133,857	0.99	3,487,287
	April	1,867,461	255,730	1,172,905	.....	25	131,844	1.90	3,296,096
	May	1,431,398	177,673	1,094,852	.....	25	108,157	14.64	2,703,923
	June	1,060,386	167,220	1,229,370	.....	26	117,576	9.99	3,056,976
	July	1,724,289	122,884	1,321,607	.....	26	121,494	11.14	3,168,840
	Aug.	1,776,480	100,035*	1,375,991	.....	26	125,096	11.93	3,252,506
	Sept.	1,714,995	69,035†	1,374,856	.....	25	126,353	9.72	3,158,886
	Oct.	1,842,427	111,075	1,271,136	57,638	27	121,565	10.51	3,282,276
	Nov.	1,567,955	70,228	1,282,311	.....	23	126,978	11.66	2,920,494
	Dec.	1,788,577	100,143	1,355,370	8,583	26	125,449	5.93	3,261,673
Total		20,520,268	1,788,390	14,747,021	170,017	305	.....	89.99	37,225,696
Average		.....	.....	.....	.....	...	122,031	....	.....
1904-06		3,887,345	.....	.....	3,103,851	...	.....	....	6,991,196
1907		10,479,037	480,030	3,527,011	1,277,117	...	.....	....	15,764,005
Total		34,887,550	2,268,420	18,274,032	4,550,985	...	.....	....	59,980,987

Total steam shovels 37,155,970
Total dredge 22,825,017
* Includes 1,389 cu. yds. excavated by hand.

Total canal prism 53,161,582
Total outside prism 6,819,405
† Includes 584 cu. yds. excavated by hand.

AN OLD SWISS CHURCH COLLAPSED near Sion, Switzerland, Jan. 10. Services were in progress at the time and the congregation was buried in the ruins. Forty persons were killed and 60 others injured. The accident is ascribed to the failure of time-worn pillars in the underground crypt.

A FIRE IN THE 600-FT. CONCRETE VIADUCT which carries Hunter's Point Ave. across the Pennsylvania R. R. tracks in Long Island City, N. Y., withstood the efforts of 50 firemen and about 200 workmen on the evening of Jan. 11 for more than two hours. To prevent freezing, the concrete had been covered with hay held in place by a sheathing of boards, and the hay is believed to have been ignited by sparks from locomotives passing under the viaduct. The fire appears to have smouldered for some time and suddenly burst into flame on half the entire length of the viaduct at the northern end. On account of obstructions presented by construction work in progress near the viaduct, it was necessary to use lines of hose over 1,000 ft. long and, in order to completely extinguish the fire, the sheathing had all to be torn away.

A CARLOAD OF BLASTING POWDER exploded Jan. 7 at Lignite, Va., instantly killing three men and seriously injuring four others. The powder was being transferred to the mines on the cars of the Oriskany Ore & Iron Corporation and it is said that powder from a defective keg was ignited by a spark from the locomotive.

ANOTHER MINE DISASTER AT THE LICK BRANCH colliery of the Pocahontas Consolidated Coal Co., near Switchback, W. Va., occurred Jan. 12. It is said that 200 men were at work in the mine, but that half of these were in a portion unaffected by the explosion and may possibly be rescued. Forty-eight dead bodies have already been recovered and it is reported that 105 were killed. Large masses of slate and coal dislodged by the explosion block the passages leading to the part of the mine where the possible survivors are entombed. The force of the explosion was such that debris was blown from both entrances and a fire has started in one of the shafts. The fans, however, were not disabled. An explosion occurred in this same mine Dec. 28 and was briefly noted in these columns Dec. 31. The body of the last victim was recovered only last Friday, Jan. 8. The total number killed in this previous explosion was 51.

AN UNUSUAL MINE EXPLOSION at the colliery of the Zeigler Coal Co., at Zeigler, Ill., Jan. 10, killed 26 of the 28 workmen who were in the mine. For about six weeks, a serious fire has been burning in the workings but had just been gotten under control to the extent of confining it in one sealed-up portion of the mine. The first coal to be hoisted from the mine, after the struggle with the fire, was brought up Jan. 9 and the explosion occurred the next morning soon after one o'clock. The peculiar features were that no sound was heard by the residents of the mining town, the only evidence of the explosion being a puff of smoke which was seen to issue from the mouth of the shaft. The interior of the mine was found not to have been damaged although many of the bodies were much mutilated. The cause of the explosion has not yet been determined, but the theory is advanced that gas escaped from the burning portions of the mine into the workings.

A HEAD-ON COLLISION between two freight trains on the Canadian Pacific Ry., 22 miles west of Chapleau, Ont., resulted in the death of one of the firemen. The trains met on a curve and the accident is said to be due to a misunderstanding of meeting orders.

AN OPEN SWITCH caused the wreck of the passenger train known as F. F. V. No. 1 on the Chesapeake & Ohio Ry., at Caperton, W. Va., Jan. 5. The accident occurred in a cut and the train crashed into the bank at the side of the track. The engineer and fireman were killed and three others were slightly injured.

TWO CASES OF TRAIN WRECKING were reported during the past week. A switch was opened by wreckers in the Pennsylvania R. R. yards at Pottsville, Pa., Jan. 6, and a freight train ran onto the siding, pushing three cars over a 35-ft. embankment into a creek. Five other cars were derailed.

Passenger train No. 272 on the Great Northern Ry. was wrecked just south of Bellingham, Wash., Jan. 7. The accident is ascribed to train wreckers. A switch had been locked open and the signal lamp extinguished, causing the train to be derailed. The fireman was killed and two persons were injured.

A 1,000-HP. VERTICAL GAS-ENGINE is in use in the Castner-Kellner Alkali Works at Runcorn, England. It has eight cylinders, in four pairs of two tandem cylinders and runs at 200 r. p. m. The lower chamber of the upper cylinder is utilized as a dash-pot, to compensate for the compression on the upstroke. The cylinders are water-jacketed, but valves and piston have no jackets. A pressure oiling system, fed by duplicate pumps, furnishes the lubrication. The engine is started with compressed air. It is direct-connected to a 230-volt dynamo, according to "Elektrotechnische Zeitschrift." This engine was built by the British Westinghouse Electric & Mfg. Co. It is believed to be the largest vertical gas engine ever built.

Personals.

Mr. Wm. H. Lawton, M. Am. Soc. C. E., has been for the fifth time elected City Engineer of Newport, R. I.

Mr. H. Batcher has been appointed Superintendent of the Southern Ry. in Mississippi. His headquarters will be at Columbus, Miss.

Mr. R. D. Parker, Resident Engineer of the Houston & Texas Central Ry., at Ennis, Tex., has been appointed to act as Engineer for the Texas Railway Commission.

Mr. Archibald El Hopkins has been appointed a Member of the Board of Water Commissioners of Passaic, N. J., to fill the vacancy caused by the death of Edson G. Davidge.

Mr. W. L. Smith, Superintendent of the Toledo, Bowling Green & Southern Traction Co., at Bowling Green, Ohio, has been elected General Manager of the City Ry. Co., of Dayton, Ohio.

Mr. J. M. Hood, Jr., Assoc. M. Am. Soc. C. E., has become Chief Engineer of the United Rys. & Electric Co., of Baltimore, Md., succeeding Mr. Chas. O. Vandevanter, M. Am. Soc. C. E., resigned.

Mr. William H. Wahl, Secretary of the Franklin Institute since 1882, has resigned on account of poor health. His place as Secretary will be temporarily filled by Mr. James Christie, M. Am. Soc. M. E.

Mr. John Laing, M. Am. Inst. M. E., President of the Wyatt Coal Co., has been appointed Chief Mine Inspector of West Virginia, succeeding Mr. James W. Paul, who is now in supervisory charge of all rescue work at the U. S. Geological Survey testing stations.

Mr. James M. Swank, General Manager and Secretary for the last 22 years of the American Iron and Steel Association, has resigned. In a letter to Mr. Joseph Wharton, President of the Association, printed in the "Bulletin" of Jan. 1, 1909, Mr. Swank requests that his successor be selected at an early day, but states his willingness to continue with his present duties pending such selection. In a note appended to this letter, the statement is made that Mr. Wharton will ask to be retired from the presidency at the time of the appointment of Mr. Swank's successor. Mr. Wharton's death is recorded in the obituary notices of our present issue.

Members of the New York State Highway Commission have been nominated by Governor Hughes, as follows: Mr. Samuel Percy Hooper, of Leroy, N. Y., chairman, for a term of six years; Mr. Thomas Warren Allen, New York City, for a term of four years; Mr. Herbert E. Cook, of Denmark, N. Y., for a term of two years. Mr. Allen, the engineer member of the Commission, was born in Hounsfield, Jefferson Co., in 1864 and graduated at Union College in 1886. He has since been engaged in river and harbor work in Louisiana and New York, and railway construction in Illinois and Pennsylvania.

Mr. George E. Ladd, M. Am. Inst. M. E., has been appointed President of the new Oklahoma School of Mines at Wilburton, Okla. Mr. Ladd was at one time Professor of Geology and Mining at the Missouri School of Mines at Rolla, Mo.

Mr. D. D. Dunkin, M. Am. Inst. M. E., and Mr. J. J. Brown, Jr., M. Am. Inst. M. E., have been appointed members of the faculty of the Oklahoma School of Mines and Metallurgy. Both Mr. Dunkin and Mr. Brown are graduates of the Missouri School of Mines and Metallurgy.

A number of changes are announced in the engineering corps of the Pennsylvania R. R. as a result of the creation of the new Hudson division which will include all the Greater New York terminals and floating equipment:

Mr. A. M. Parker, Principal Assistant Engineer of the New Jersey division, has become Superintendent of the new Hudson division.

Mr. George P. Miller, Assistant Engineer of the New York division at Jersey City, N. J., has become Principal Assistant Engineer of the New Jersey division, succeeding Mr. Parker.

Mr. R. V. Massey, hitherto Assistant Engineer at Reading, Pa., will be Assistant Engineer of the New York division succeeding Mr. Miller.

Obituary.

James Corrigan, leading member of the firm of Corrigan, McKinney & Co., and President of three blast furnace companies in Pennsylvania, died in Cleveland, Ohio, Dec. 24, at the age of 79 years.

Joshua Rhodes, formerly President of the Pennsylvania Tube Co., died at his home in Pittsburg, Pa., Jan. 5. Mr. Rhodes was born in London, Eng., in 1824 but came to this country when only four years old. He had retired from active business a short time before his death.

Alfred R. Wolff, M. Am. Soc. M. E., died at his home in New York City, Jan. 6. Mr. Wolff was born in 1849 and graduated at Stevens Institute in the class of 1876, which was one of the earliest classes sent out by the institute and included several members who have attained great prominence as engineers. He was probably one of the very first engineering graduates to take up as a specialty heating and ventilation, and he has for years been recognized as the leading authority on this branch of engineering in the United States. Among his most recently completed undertakings were the designs of the heating and ventilating plants for the Public Library and the Municipal Building in New York City.

Joseph Wharton, President of the American Iron and Steel Association and prominent as an official and owner of a number of iron and steel manufacturing companies, died at his home in Philadelphia, Pa., Jan. 11, at the age of 83 years. Mr. Wharton was born in Philadelphia March 3, 1826, and was one of the five children of William and Deborah Fisher Wharton who were both Friends. He was educated first by private tutors and at the Friends' School, and finally was prepared for Harvard University at a private school conducted by Mr. Frederick A. Eustis. He did not enter Harvard, however, but went to work on a farm, studying French and German in the evenings and studying chemistry at Boye's Laboratory, Philadelphia, in the winter time. His next work was as an office boy in a dry goods house in Philadelphia, of which he soon became bookkeeper. When 23 or 24 years old he became manager of the Lehigh Zinc Co., of which he assumed complete control as lessee in 1853, and during this period he established the first successful spelter furnaces in America. When his lease expired, in 1863, he turned his attention to the production of nickel, which was at that time so scarce that the U. S. Government had discontinued the coinage of the nickel-alloy one-cent piece. He acquired a nickel mine in Lancaster Co., Pa., and an abandoned nickel refining plant in Camden, N. J., and produced at this plant the first malleable nickel ever made.

During this same period he was gradually acquiring a controlling interest in the Bethlehem Steel Works and eventually became a director of that company. The first armor plate made in this country was manufactured for the U. S. Navy at the Bethlehem Steel Works while Mr. Wharton was in control. After the sale of the Bethlehem Works in 1901 to interests represented by Charles M. Schwab, Mr. Wharton built four blast furnaces with a capacity of 1,000 tons per day at Wharton, N. J. He owned at this time 5,000 acres of ore lands and 31,000 acres of coal lands in Pennsylvania and Virginia.

Mr. Wharton was the founder of the Wharton School of Finance at the University of Pennsylvania, endowed the chair of history and political economy at Swarthmore College, and made a gift to that college of the building known as Wharton Hall. The scientific laboratory at Swarthmore was established by him in conjunction with the late Samuel Willetts, of New York, and he was President of the board of managers of the college. He was a member of the Iron and Steel Institute, a director of the Lehigh Valley R. R. and President and director of numerous other iron and railway companies in which he was interested.

Engineering Societies

COMING MEETINGS.

INDIANA ENGINEERING SOCIETY.
Jan. 14-16. Annual convention at Indianapolis, Ind. Secy., Charles Brossman, Union Trust Bldg., Indianapolis, Ind.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 19. Annual meeting at New York City. Secy., W. M. Mackay, P. O. Box 1818, New York City.

WOOD PRESERVERS' ASSOCIATION.
Jan. 19. Annual meeting at Chicago, Ill. Secy., C. W. Berry, Union Pacific R. R., Topeka, Kan.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 20. Annual meeting at New York City. Secy., Charles W. Hunt, 220 West 57th St., New York City.

OHIO ENGINEERING SOCIETY.
Jan. 26-28. Annual convention at Columbus, Ohio. Secy., Paul Hansen, Harrison Bldg., Columbus, Ohio.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 27-29. Annual meeting at Chicago, Ill. Secy., E. E. R. Tratman, 1636 Monadnock Block, Chicago.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 28. Annual meeting at Toronto. Secy., C. H. McLeod, 413 Dorchester St., W., Montreal, P. Q.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Feb. 1-6. Annual convention at Rochester, N. Y. Secy., T. A. Randall, Indianapolis, Ind.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 9. Annual meeting at Hartford, Conn. Secy., J. Frederick Jackson, Box 1304, New Haven, Conn.

NEW ENGLAND GAS ASSOCIATION.
Feb. 17-18. Annual meeting at Boston, Mass. Secy., N. W. Gifford, East Boston Gas Co., East Boston, Mass.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 23. Annual meeting at New Haven, Conn. Secy., R. W. Raymond, 29 West 39th St., New York City.

NORTHWESTERN CEMENT PRODUCTS ASSOCIATION.
March 2-4. Annual convention at Minneapolis, Minn. Secy., J. C. Van Doorn, 836 Security Bank Bldg., Minneapolis, Minn.

AMERICAN FORESTRY ASSOCIATION.—At the 26th annual meeting held at Washington, D. C., Jan. 13-14, the control of forest fires, state and national forests, the White Mountains and Southern Appalachians will be discussed. The final session will deal with the subject of forestry education.

NEW YORK STATE WATERWAYS CONFERENCE.—A meeting will be held in Brooklyn, N. Y., Jan. 21-22 for the discussion of ways and means of securing the improvement of the waterways of the State of New York. The Secretary is Mr. James T. Hoile, 198 Montague St., Brooklyn, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—Among the committees which will present their reports at the annual meeting in New York, Jan. 20, are the special committee to which was referred an amendment to the constitution of the society at the last annual convention and the committee on the Status of the Metric System in the United States. The report of the latter committee was published in the "Proceedings," October, 1908. In the afternoon of the same day, a party will cross the Blackwell's Island Bridge in automobiles and will return to New York on the Williamsburg Bridge, concluding the trip with a visit to the Chelsea section of docks on North River. The second day of the meeting, Jan. 21, will be devoted to a visit to the Ashokan Reservoir.

WESTERN SOCIETY OF ENGINEERS.—The annual meeting was held in Chicago on Jan. 5 and was followed by a dinner. Three addresses of special interest were made, as noted below. That by Gen. Dodge related largely to his work in connection with the Union Pacific Ry., the first of the transcontinental railways. The addresses were as follows: "Engineering in China and Japan," by Onward Bates, who visited those countries in 1908; "The Engineering Work in the West in an Early Day and During the Civil War," by Gen. Grenville M. Dodge; "The Railway Situation of To-day," by Frank Trumbull.

The committee on the award of the Octave Chanute medals announced awards as follows: (1) Civil Engineering, to F. E. Turneaure, for his paper on "Experimental Determination of Stresses in Web Plates and Stiffeners in Plate Girders"; (2) Mechanical Engineering, to Walter T. Ray and Henry Kreisinger for their paper on "The Nature of True Boiler Efficiency"; (3) Electrical Engineering, to D. W. Roper, for his paper on "A Few Unusual Burnouts of Underground Cables."

Mr. Octave Chanute was elected an Honorary Member by the Board of Direction, this action being taken in accordance with a petition signed by a large number of members, and being in recognition of his long and distinguished professional career. His membership dates from 1869, when the Civil Engineers' Club of the Northwest was formed, that organization having been the predecessor of the present Western Society of Engineers.

The officers for 1909 are as follows: President, Andrews Allen; Vice-Presidents, P. Junkersfeld, O. P. Chamberlain and Dr. W. F. M. Goss; Treasurer, Albert Reichmann; Secretary, J. H. Warder.

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